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ELECTRO-MOTORS.

THE transmission of power to a distance by means of electric motors is likely to prove one of the most promising developments of electrical engineering, and the fact that the subject, although it has made fair progress, has not been brought forward, with one exception, in a highly sensational way augurs well for its having a future sound commercial value. For speculative purposes something to make a great show is, as a rule, very necessary, but the more really successful enterprises are generally the result of a quiet development.

The paper recently read by Professors Perry and Ayrton before the Society of Telegraph Engineers and of Electricians, on the subject of electro-motors, has added a considerable amount of useful information on the subject, though some of the conclusions which these gentlemen drew are not, we think, borne out by facts; indeed, the motors which they have designed, and which we understand are constructed on theoretical principles deduced from a mathematical analysis, show an efficiency which is less than that given by machines which, according to those principles, should be decidedly less effective. With reference to the paper read before the before-mentioned Society, we think it would be well if more discretion were exercised in the subject matter considered, the practice of treating an audience with a number of mathematical formulæ which are not understood by a large number, and which are received with manifest signs of impatience by the great majority, is reprehensible, and suggests the thought that the authors are only actuated by a desire to air their mathematical knowledge at the expense of their hearers. Mathematical formulæ are, of course, necessary for the development of a subject; but it is almost always sufficient to give the conclusions arrived at, and to leave the mathematical working from which the conclusions are derived, to be printed in the proceedings of the Society.

Profs. Perry and Ayrton, in comparing the efficiency of various electro-motors, give the relative values of their efficiencies weight for weight, the total weights of the machines, *i.e.*, the base plates and framework included, being taken. A comparison of this kind can, we think, hardly be considered a satisfactory one; for practically it makes the efficiency of the machine to partly depend upon the non-effective portions, which are almost wholly independent of the principle of the machine. The authors of the paper stated that electro-motors, weight for weight, were capable of developing more power than a steam engine; in making this comparison the weight of the motor alone was taken against the weight of the steam engine and boiler together. Such a comparison is decidedly open to criticism, and will hardly be accepted as being satisfactory.

The necessity for an efficient regulator for electro-motors exists as much as it does in the case of a steam-engine, but the difficulties of producing an efficient apparatus for the purpose of effecting the regulation are very great in the case of the electro-motors, and Professors Ayrton and Perry's ingenious method of effecting the regulation by making the current set up in the motor weaken the field magnets, is a step in the right direction.

The table of experimental results, which we give in our report of the "Proceedings of the Society of Telegraph Engineers and Electricians," does not bring some of the more recent motors into a very favourable light; the efficiency of the Jablochkoff motor, for example, is as low as 3·7 per cent. The Siemens motor, however, gives an efficiency as high as 75 per cent., the machine being of comparatively large dimensions; it was found, in fact, that large machines were considerably more efficient than those of smaller dimensions. If this is the case universally, the amount of waste resulting from the transmission of power by electro-motors must, for commercial purposes, be very considerable; since the employment of small motors would probably be much more extensive than the employment of large ones.

THE POST OFFICE AND INVENTORS.

OUR readers are aware that a paper on the Government Patent Bill was read before the Society of Arts last month by Mr. H. Trueman Wood, B.A. We have already noticed this subject in a leading article, and we think that the remarks of two well-known gentlemen who took part in the discussion on Mr. Wood's paper are worthy of reproduction *in extenso*.

Mr. W. H. Preece, F.R.S., said there was little or nothing in the Bill before them with which he had to find fault, though there was something in the paper read by Mr. Wood with which he intended to find serious fault. There was no more difficult thing in this world to eradicate than a well-established popular delusion, and the higher the intelligence, and the higher the position of those minds in which a popular delusion was fixed, the greater, apparently, was the difficulty of eradicating it. Mr. Wood had alluded to the fact that inventions were rather checked by the existing monopoly of the Crown, with regard to the establishment of inventions in this country, and he instanced one of the popular delusions, which was, that the Crown had a monopoly in telegraphic apparatus. He might state deliberately that the Crown had no more monopoly in the invention of electric telegraphs than it had in the use of mail carts or red coats. The telegraphs of this country were open to everybody. The telegraph service of this country, which was manipulated by the Post-office, was simply a flea-bite in the use of apparatus for telegraphic purposes, for of the 60,000 instruments at present in use, only about one-fifth were in the hands of the Government. In England, there were some ten or twelve telegraph companies, as well as innumerable railway companies, to whom inventors could go with their inventions, and to say that the Post-office or the Crown had a monopoly in telegraphic apparatus was absolutely erroneous. What they had a monopoly in, was quite a different thing, namely, in the transmission of letters and messages for which money was paid. It was quite true that according to the legal reading of the Patent-laws there were certain rights of the Crown, which, under certain circumstances, must be exercised; but speaking from his own experience, and from the experience of the Post-office, he could positively say that these rights were never exercised. It was one of his unfortunate duties to have to investigate the claims and merits of inventions, and the number which came before him was usually two every day of the year. There had never yet been a single invention, however poor its author, brought before the Post-office which had not been carefully considered, nor had there ever been an improvement of merit which was not adopted, and if adopted, paid for. At the present moment the Post-office was one of the largest payers

of royalties in the country for patents. In the Bill of 1879, which was produced by Sir John Holker, it was proposed to insert a clause placing Government departments in the same position as private individuals, but in the present Act this clause had been omitted for a very good reason, that if an invention was favourably considered, the inventor was sure to open his mouth to the Government about 100 times wider than he would to a commercial concern. The result was that it was thought advisable to keep some kind of control over these wide-mouthed inventors. Some of the demands made upon the Government in respect of inventions were simply outrageous, but provision was made in the present Bill for breaking through this kind of thing by providing that all patentees should grant licences under compulsory powers, to be exercised and controlled by the Board of Trade or some other body. Considering the insertion of this particular clause, and the fact that the Government did not, except with warlike material, exercise its Crown rights, he did not see upon what ground inventors complained of the omission of this particular clause. He had looked with a good deal of favour upon the introduction of this particular Act, as it facilitated and simplified to a very great extent the obtaining of patents, especially by the working classes. Moreover, it did a great deal to bring a patent within the reach of persons with a moderate purse, and it also brought the law of England more in accord with the law of America. Speakers were very fond of drawing a comparison between the English and American Patent laws. It has often been stated that inventions are so prolific in the United States because their patent laws are so good; but he thought that the law was a consequence of the popular feeling, rather than the cause of any peculiar inventive faculty in that country. The way in which inventors were treated in America was very different to that in which they were treated in this country. In America, if a man brought forward an invention, it was immediately looked at and considered, and perhaps accepted, but in England the inventor was looked upon as a man to be avoided. This state of affairs he was happy to say, was now being altered, owing to the manner in which the question had been taken up and discussed by the Society of Arts and in other places, and owing to the fact that within the last few years new and startling inventions had been brought to the door of everybody, such, for instance, as the telephone and electric lighting. The result of all this was that an inventor was now being looked upon as a person to be taken by the hand. He thought that the proposed Bill was a great improvement upon all previous Acts, and he hoped that it would pass, and be found to be a boon to inventors.

Sir William Siemens, F.R.S., said, although he had given a great deal of attention to the question of patent-law for many years, he had not studied the present Bill with the care he should have liked to give it. Still he had gathered the points of difference between the Government Bill and that proposed by the Society, and was disposed to agree with most of the observations of Sir Frederick Bramwell. The question of making it easy for poor inventors to get a patent was one which most people were agreed on, and he could not well understand how the Board of Trade could bring forward a Bill which, though it possessed many advantages, would still make it very difficult and costly for a poor inventor to obtain protection. Such a man had not the means of ascertaining all that had gone before him, and he had not that logical mind which would enable a man of more liberal education to at once formulate his invention so as to give a distinct idea of what he intended to claim. He should himself find it impossible to frame a claim such as would stand examination in a court of law, in making a first application for a patent. It took at least four or five months of study and experiment to give an inventor's conception that definite form which was necessary before he could prepare a claim. In that respect, therefore, he hoped the Bill would be amended. Besides that, it was proposed that this precisely formulated invention was to be laid open to the public, to be scrutinised, amongst others, by manufacturers who might be desirous of availing themselves of the inventor's ideas, without considering his rights; and thus the inventor had to run the gauntlet of a kind of law suit at the first start, in order to substantiate his application, which would again be a great hardship on a poor man. Then came the question of the officers appointed to examine the application, and report to their superior, with an appeal to the law-officer, and this organisation appeared to him to be insufficient. He thought the law-officers were perhaps the best judges on any legal point which might arise, but it would be impossible for them to attend to the duties of a patent commissioner. If the examination was simply into the form of application, to see whether it was consistent with the rules, it might be sufficient, but this examination would be of very little value. In his opinion, the examination should certainly comprise the question of novelty. It did not follow that the office should have power to refuse an application, but it ought to assume the position of an honest dealer. If a person came before it to-day and asked for a patent, and a fortnight later another man came with a similar application, was the examiner to say, this is a good application, as far as form goes; exactly the same thing was applied for a fortnight ago, but that is not my business, and therefore you may pay your money and get your patent, though afterwards you may find out that the same patent has been granted twice over? He called that dishonest dealing. Surely the office should say this application cannot be of any use, because the same thing has been granted before. If the application were referred back to the applicant, he would see probably that, notwithstanding the previous patent, there might be something new in his idea, and it would be quite possible that he would, after some consideration, make a very good application for a patent. It might be said that the inventor had his patent agent to go to; but how was it possible for a patent agent to examine the whole of the patent records? He would, no doubt, advise his client to the best of his judgment, but a search throughout the documentary evidence in the Patent-office would be entirely beyond his power. On the other hand, the patent examiner, who would probably take one branch of applied science, would have it at his fingers' ends, would know by heart what had been done, and could say at once, "Your application interferes with so-and-so; examine these and then come here again." In this respect he approved of the German Patent-law. He had taken a good many patents under that law, and had found it a great advantage to be advised, as it were, by the patent commissioners. The result had been that his patents had been more judiciously worded than would otherwise have been the case. Perhaps rights were claimed which would be rather objected to in this country, because, after an appeal to the chief commissioner, a patent could be absolutely refused on the ground of want of novelty; but instead of that, they might adopt the suggestion which was thrown out by Sir Frederick Bramwell, that if anybody insisted on having a patent after being informed of what was before him, it should be granted, with a statement of the advice received from the patent commissioner. That would be a guarantee against a person insisting on a patent for unfair purposes, and he would not run any risk of being unfairly dealt with. Next came the question which had been already argued, whether the Government should be exempt from the operation of the Patent-law; and on that point it appeared to him that Mr. Preece had drifted into certain inconsistencies. He said that his department had always been most ready to reward inventors. He must say that he had not heard of great rewards being paid to outside inventors by any Government department; but supposing the Post-office had been so generously minded, notwithstanding the difficulty which Mr. Preece mentioned, of getting the Treasury to fall in with their liberal views, would it not be better for the inventor, if he could go before Mr. Preece, not as a petitioner, asking a reward, but with some right to stand upon. Mr. Preece's idea seemed to be that he should come, hat in hand, and say, here is an invention of mine, I beg of you to give me something for it. That was not a position which he for one would care to assume. The other proposition which Mr. Preece approved of, and which he had always advocated, was that of compulsory licenses. He remembered the time when he was blamed by the advocates of patent rights for pressing it, but he considered it was fair all round. A patentee was not a monopolist; he was the holder of a public trust, and ought to administer the trust fairly, and if he would not, he should be compelled. The Government might take full advantage of this right. If a patentee made exorbitant claims, he would be simply told that his claims would be inquired into, and whatever was his

due he would receive and nothing more. Mr. Preece said the Post-office exercised no monopoly, but in that he could not follow him. If you wanted to make a private line of telegraph on your own estate you could do so, but you could not communicate with the outer world. You might communicate from your house to your stables, but the moment you wished to communicate with the nearest telegraph station, you would be told to pull down your own line, and to go to the Post-office to get a new one made. Everything must be done by the Post-office. That might be quite consistent from a Government point of view, but it made a gross monopoly, and the only people exempt from it were companies or persons who put up lines on their own property. A man with an estate of a square mile might put up a telegraph on it, and a railway with a line 100 miles long might put up a telegraph along that railway, but there they must stop. Telegraphy ought to go from one end of the country to the other, and not be stopped by any such boundaries. If patentees had a chance at the Post-office at present, it was merely by favour, and not by right, as he should like to see it.

The author of the paper afterwards said he hardly felt that he had any right to a reply, his paper having been only brought forward with a view of eliciting discussion, and from that point of view he was glad to be able to say that it had been highly successful. He was not prepared to dispute Mr. Preece's statements, and on matters of fact, of course, they would all accept what he said; but if Mr. Preece had met one of his objections, he had supplied a far stronger one. If the Government did not want to use the power of using inventions without paying for them, why should it be retained? If they really meant that they could not make a proper bargain with an inventor unless they had this threat in the background, and could say to him—unless you will sell your invention at a cheaper rate than we have any right to buy it from you we will steal it, the less said about it the better.

The Chairman (Mr. R. E. Webster, Q.C.) then proposed a vote of thanks to Mr. Wood for his paper, and said, with regard to the remarks of Mr. Preece, that there was a simplicity about his argument which was quite refreshing. That gentleman said there was nothing to fear—that there never was an invention which was not carefully considered, and adopted if it were good, and never one which was not paid for liberally. Well, that was all they wanted. What they protested against, and it was by no means an illusion raised up by patentees for the sake of creating a grievance, was the idea which had been maintained by the Government that patents did not bind the Crown. Mr. Preece said very fairly that the Government did not want to take advantage of any man's brains without paying for it; then let them say, once for all, that the Crown should not have the benefit of an invention without paying fairly for it.

LECTURES ON ELECTRICAL SCIENCE.

THE last of the series of lectures on the practical applications of electricity, being on "Electrical Units of Measurement," by Sir William Thomson, F.R.SS.L. and E., M. Inst. C.E., was delivered before the members of the Institution of Civil Engineers on Thursday evening, the 3rd of May, 1883.

The lecturer began by observing that no real advance could be made in any branch of physical science until practical methods for a numerical reckoning of phenomena were established. The "scale of hardness" for stones and metals used by mineralogists and engineers was alluded to as a mere test in order of merit in respect to a little understood quality, regarding which no scientific principle constituting a foundation for definite measurement had been discovered. Indeed it must be confessed, that the science of strength of materials, so all important in engineering, is but little advanced, and the part of it relating to the quality known as hardness least of all.

In the last century Cavendish and Coulomb made the first advances towards a system of measurement in electrical science, and rapid progress towards a complete foundation of the system was effected by Ampère, Poisson, Green, Gauss, and others. As late as ten years ago, however, regular and systematic measurement in electrical science was almost unknown in the chief physical laboratories of the world; although as early as 1858 a practical beginning of systematic electric measurement had been introduced in the testing of submarine telegraph cables.

A few years have sufficed to change all this, and at this time electric measurements are of daily occurrence, not in our scientific laboratories only, but also in our workshops and factories where is carried on the manufacture of electric and telegraphic apparatus. Thus, ohms, volts, ampères, coulombs, and micro-farads are now common terms, and measurements in these units are commonly practised to within 1 per cent. of accuracy. It seems, indeed, as if the commercial requirements of the application of electricity to lighting and other uses of every-day life were destined to influence the higher region of scientific investigation with a second impulse, not less important than that given thirty years ago by the requirements of submarine telegraphy.

A first step toward the numerical reckoning of properties of matter, is the discovery of a continuously-varying action of some kind, and the means of observing and measuring it in terms of some arbitrary unit or scale division: while the second step is necessarily that of fixing on something absolutely definite as the unit of reckoning.

A short historical sketch was given of the development of scientific measurement, as applied to electricity and magnetism, from its beginning with Cavendish, about 100 years ago, to the adoption of the absolute system of measurement by this country in 1869, at the instance of the British Association Committee on Electric Standards. The importance in this development of the originating works of Gauss and Weber was pointed out, as also of the eight years' labours of the British Association Committee. This committee not only fairly launched the absolute system for general use, but also effected arrangements for the supply of standards for resistance coils, in terms of a unit, to be as nearly as possible 10^9 centimetres per second. This unit afterwards received the name of the ohm, which was adopted from a highly suggestive paper which had been communicated to the British Association in 1861, by Mr. Latimer Clark and Sir Charles Bright, in which some very valuable scientific methods and principles of electric measurement were given, and a system of nomenclature—ohmads, kilohmads, farads, kilofarads, volts, and kilovolts—now universally adopted with only unessential modification, was proposed for a complete system of inter-dependent electric units of measurement. At the International Conference for the Determination of Electrical Units, held at Paris in 1882, the absolute system was accepted by France, Germany, and the other European countries; and Clark and Bright's nomenclature was adopted in principle and extended.

Gauss's principle of absolute measurement for magnetism and electricity is merely an extension of the astronomer's method of reckoning mass in terms of what may be called the universal gravitation unit of matter, and the reckoning of force, according to which the unit of force is that force which, acting on unit of mass for unit of time, generates a velocity equal to the unit of velocity. The universal-gravitation unit of mass is such a quantity of matter, that if two quantities, each equal to it, be placed at unit distance apart, the force between them is unity.

Here mass is defined in terms of force and space, and in the preceding definition force was defined in terms of mass, space, and time. Eliminating mass between the two, it will be found that any given force is numerically equal to the fourth power of the velocity with which any mass whatever must revolve round an equal mass, fixed at such a distance from it as to attract it with a force equal to the given force. And, eliminating force between the two primitive definitions of the universal-gravitation system, it will be found that any given mass is numerically equal to the square of the velocity with which a free particle must move to revolve round it in a circle of any radius, multiplied by this radius. Thus, take a centimetre as the unit of length, and a mean solar record as the unit of time, and adopt 5·67 grammes per cubic centimetre as the mean density of the earth from Baily's repetition of Cavendish's experiment, and suppose the length of the seconds pendulum to be 100 centimetres, and neglect the oblateness of the earth and the centrifugal force of its rotation (being at the equator only $\frac{1}{289}$ of gravity) the result for the universal-gravitation units of mass and force is respectively 15·36 French tons, and 15·36 dynes, or 15·07 times the terrestrial surface weight of a kilogramme.

The ultimate principles of scientific measurement were illustrated by the ideal case of a traveller through the universe who has brought with him on his tour no weights, no measures, nor watch or chronometer, nor any standard vibrator or spring balance, but merely Everett's units and constants and a complete memory and understanding of its contents, and who desires to make for himself a metrical system agreeing with that which he left behind him on the earth. To recover his centimetre the readiest and most accurate way is to find how many wave lengths of sodium light there are in the distance from bar to bar of a plating which he can engrave for himself on a piece of glass. How easily this is done, supposing the grating once made, was illustrated by a rapid experiment performed in the course of the lecture, without other apparatus than a little piece of glass with 250 fine parallel lines engraved on it by a diamond, and two candles and a measuring tape of unknown divisions of length (only used to measure the *ratio* of the distance between the candles to the distance of the grating from either). The experiment showed the distance from centre to centre of consecutive bars of the grating to be 32 times the wave length of yellow light. This being remembered to be $5{\cdot}89 \times 10^{-5}$ of a centimetre, it was concluded that the breadth of the space on which the 250 lines are engraved is $250.\ 32.\ 5{\cdot}892.\ 10^{-5}$, or ·4726 of a centimetre. According to the instrument maker it is really ·5 of a centimetre! Five minutes spent on the experiment instead of one, and sodium flames behind fine slits, instead of open candles blowing about in the air, might easily have given the result within one-half per cent. instead of 4½ per cent. Thus the cosmic traveller can easily recover his centimetre and metre measure. To recover his unit of time is less easy. One way is to go through Foucault's experimental determination of the velocity of light.

But, he must be imagined as electrically-minded; and he will, certainly, therefore, think of "v," the number of electrostatic units in the electro-magnetic unit of electricity; but he will, probably, see his way better to doing what he wants by making for himself a Siemens mercury unit (which he can do easily, now that he has his centimetre), and finding (by the British Association method, or

Lorenz's with Lord Rayleigh's modification or both), the velocity which measures its resistance in absolute measure. This velocity, as is known from Lord Rayleigh and Mrs. Sidgwick, is 9,413 kilometres per mean solar second, and thus he finds, in mean solar seconds the period of the vibrator, or arbitrary-unit chronometer, which he used in his experiments.

Still, even though this method might be chosen as the readiest and most accurate, according to present knowledge of the fundamental data for recovering the mean solar second, the method by "v" is too interesting and too instructive in respect to elimination of properties of matter from our ultimate metrical foundations to be unconsidered. One very simple way of experimentally determining "v" is derivable from an important suggestion of Clark and Bright's Paper, referred to above. Take a Leyden jar, or other condenser of moderate capacity (for example, in electrostatic measure, about 1,000 centimetres), which must be accurately measured. Arrange a mechanism to charge it to an accurately measured potential of moderate amount (for example, in electrostatic measure, about 10 c.g.s., which is about 3,000 volts), and discharge it through a galvanometer coil at frequent regular intervals (for example, ten times per second). This will give an intermittent current of known average strength (in the example, 10^5 electrostatic c.g.s., or about 1/300,000 c.g.s. electro-magnetic, or 1/30,000 of an ampère), which is to be measured in electro-magnetic measure by an ordinary galvanometer. The number found by dividing the electrostatic reckoning of the current, by the experimentally found electro-magnetic reckoning of the same, is "v," in centimetres per the arbitrary unit of time, which the experimenter in search of the mean solar second has used in his electrostatic and electro-magnetic details. The unit of mass which he has chosen, also arbitrarily, disappears from the resulting ratio. It is to be hoped that before long "v" will be known within 1/10 per cent. At present it is only known that it does not *probably* differ 3 per cent. from $2{\cdot}9 \times 10^{10}$ centimetres per mean solar second. When it is known with satisfactory accuracy, an experimenter, provided with a centimetre measure, may, anywhere in the universe, rate his experimental chronometer to mean solar seconds by the mere electrostatic and electro-magnetic operations described above, without any reference to the sun or other natural chronometer.

The remainder of the lecture was occupied with an explanation of the application of the absolute system in all branches of electric measurement, and the definition of the now well known practical units founded on it, called ohms, volts, farads, microfarads, ampères, coulombs, watts. The name mho, found by saying ohm to a phonograph and then turning the drum backwards, was suggested for a unit of conductivity, the reciprocal of resistance. The sub-division, millimho, will be exceedingly convenient for the designation of incandescent lamps.

The British Association unit has been found by Lord Rayleigh and Mrs. Sidgwick to be ·9868 of the true ohm (10^9 centimetres per second), which differs by only $\frac{1}{2}\frac{1}{0}$ per cent. from ·9870, the number derived from Joule's electrothermal measurements described in the British Association Committee's report of 1867, with 772 Manchester foot-pounds taken as the dynamical equivalent of the thermal unit from the measurement described in his Royal Society paper of 1849, and confirmed by his fresh measurement of 20 years later, published in his last Royal Society paper on the subject.

It is satisfactory that, whether for interpreting old results, or for making resistance-coils anew, electricians may now safely use the British Association unit as ·9868, or the Siemens unit as ·3413, of the ohm defined as 10^9 centimetres per second.

ELECTRIC POTENTIAL, ENERGY AND WORK.

By Lieut. BRADLEY A. FISKE, U.S.N.*

IN no study more than in that of electrical science is a clear comprehension needed of the terms used in the nomenclature, and of the laws under which the forces act. The purely experimental stage of its development has passed, and we have now reached a point where theory and practice must work hand in hand. A careful effort to apply its principles to its practical applications will discover the methods of securing effects by the most rapid and inexpensive means, and it is a well-known fact that the surprising results obtained in practice by many inventors are not due to happy inspiration or to experiment alone, but also to profound and laborious calculation.

To many, the terms heading this paper convey a very indefinite meaning, and their relation to the question of electric supply, lighting, &c., seem very remote. It can be shown, however, that they possess a most real and absolute signification, and that they bear directly upon nearly all the problems of electrical engineering.

The books tell us that electric potential means power to do electrical work, and that the difference of potential between two points is the number of units of work necessary to be done on a plus unit of electricity in order to move it from one to the other.

Work, as is well known, is the product of force by distance. In order to ascertain the relations between electrical and mechanical work, it has been necessary to devise units in terms of which both can be expressed.

In the system invented, known as the c. g. s. system, the unit of force is called the *dyne*, and means that force which, acting for one second on a mass of one gramme gives it a velocity of one centimetre per second. The unit of length is the centimetre; and the unit quantity of electricity assumed is that which, placed at a distance of one centimetre from a similar and equal quantity, repels it with a force of one dyne.

The dyne being the unit of force, and the centimetre the unit of length, the unit of work must be the dyne-centimetre. To this unit is given the name *erg*.

From the fact that charges of electricity of similar name repel one another, it is evident that to move a plus unit of electricity towards a plus charge necessitates the expenditure of work. Supposing the plus unit to be at an infinite distance from the plus charge, and therefore free from its influence, and then to be moved towards it, the number of ergs expended in getting it up to a certain point expresses the potential of that point. To move the unit to a point nearer the charge would clearly require a greater expenditure of work; in other words, the potential of the second point would be higher.

Now, it is obvious that to move any plus unit from the first to the second point would require an amount of work equal to the difference of the two amounts; so that, if this difference were one erg, the difference of potential between the two points would be one.

If, on the other hand, instead of raising a quantity of electricity from a lower to a higher potential, we allow it to fall from a higher to a lower, it will, in accordance with the law of conservation of energy, perform exactly the same work as was expended upon it in raising it, through the same difference of potential.

We see at once that this is the case with which we have to deal in computing the electrical work done in any circuit, for there we find units of electricity falling through units of potential. The units (called electro-magnetic units) are different from those thus far considered (called electro-static), but the same laws evidently apply.

An electro-magnetic unit of quantity is that carried in one second by a current of such a strength that, if a length of it equal to one centimetre be bent into an arc having a radius of one centimetre, it will act with a force of one dyne on a unit magnet pole placed at its centre. Now, this unit bears to the electro-static unit the ratio LT^{-1}; but as the electro-magnetic difference of potential bears to the electro-static the ratio

$$\frac{1}{LT^{-1}}$$

one electro-magnetic unit performs just one erg of work in falling through one electro-magnetic unit of potential.

Therefore, if we know the strength of current passing through any circuit or part of a circuit, and the potential through which it falls in so passing, the work performed in one second is clearly C E, or as sometimes written,

$$C^2 R \text{ or } \frac{E^2}{R}$$

But, as these units are manifestly too small, larger and more practical ones are used. Of these, the volt equals 10^8 electro-magnetic units of potential, and the ohm equals 10^9 electro-magnetic units of resistance. Necessarily, therefore, the practical unit of quantity is 10^{-1} times the electro-magnetic unit.

Therefore, if in measuring with our practical instruments, we find a strength of current C′ and a fall of potential E′, it is obvious that the work done in one second is in ergs,

$$C' E' \times 10^7.$$

Knowing, as we do, that one horse-power means an energy of 746×10^7 ergs in one second, the horse-power performed is, of course,

$$\frac{C' E' \times 10^7}{746 \times 10^7} = \frac{C' E'}{746}$$

or, as often written,

$$\frac{E^2 \times 44{\cdot}24}{R \times 33000}$$

* Contributed to Van Nostrand's *Engineering Magazine*.

As it is potential which does the work of driving the current through the resistances of the circuit, it follows that less potential is expended in any circuit in overcoming the small resistances than the great ones. From this it follows again that, in any simple circuit, the fall of potential in different parts is proportional to the resistances of those parts; and also that, as no generator, whether battery, accumulator, or machine, is a perfect conductor of electricity, we must not neglect to take its resistance into consideration. This is frequently neglected, and great mistakes sometimes ensue in consequence. The Electrical Power Storage Company, in England, gave out recently that the number of their accumulators necessary to feed a given number of incandescence lamps could be calculated by simply dividing the potential needed for one lamp by the electromotive force of one cell. Though plausible upon its face, this rule is clearly incorrect, for the reason that all of the electromotive force generated is not furnished to the external circuit, but only the fraction thereof, represented by the quotient of the external resistance divided by the generator's resistance plus the external resistance. Evidently, when a great many lamps in multiple arc are fed by a number of accumulators in series, the distribution of potential is far from being the same that it is when only a few are supplied. Suppose we wish to know how many accumulators, having each an electromotive force, e, are necessary to supply n incandescence lamps, having each a resistance r' when hot, the potential necessary for each lamp being e'.

The whole current necessary, then, is

$$\text{C} = n\,\frac{e'}{r'}.$$

Suppose the current which each cell is capable of furnishing most economically to be c. Then we must have such a number of series of cells that the whole current shall be c. Letting y = this number—

$$y = \frac{\text{C}}{c}.$$

Let x = No. cells of each series,
„ r = resistance of each cell,
„ R = „ „ conductors.

Then

$$\text{C} = \frac{xe}{\frac{xr}{y} + \frac{r'}{n} + \text{R}} = \frac{xeny}{nxr + r'y + \text{R}ny}.$$

$$\text{C}nxr + \text{C}r'y + \text{CR}ny = xeny$$
$$x(eny - \text{C}nr) = \text{C}r'y + \text{CR}ny.$$

But

$$\text{C} = \frac{ne'}{r'} \therefore n = \frac{r'\text{C}}{e'}$$

$$\therefore x(ey - \text{C}r) = e'y + \frac{\text{R}}{r'}ne'y.$$

$$x = \frac{e'y + \frac{\text{R}}{r'}ne'y}{ey - \text{C}r}.$$

In case R is very small as compared with r', this formula may be written—

$$x = \frac{e'y}{ey - \text{C}r}.$$

It will be noticed that we have considered this as a simple circuit by taking the joint resistance of the lamps and conductors as a single external resistance.

In calculating the fall of potential in any branch of a divided circuit, we have to deal with somewhat different conditions. When two or more branches divide and reunite at common points, the difference of potential at the ends of each branch, instead of being that due to the resistance of that branch, is only that due to the joint resistance of all the branches. When lamps or motors are supplied in multiple arc, however, we cannot say that the difference of potential supplied to each lamp is that due to the joint resistance of all the lamps, even if all are burning, for the obvious reason that each lamp does not get its wires direct from the generator, and that all are not at the same distance therefrom. For this reason the potentials furnished to all the lamps are not equal, but vary with their distances from the generator, or rather with the resistances of the mains between the generator and the points from which the lamps draw their supply. Clearly, a lamp near the generator will get the benefit of nearly the whole potential furnished to the circuit, for the reason that it takes one wire from very near the positive pole of the generator, and the other from very near its negative pole; while the case of the lamp farthest away is manifestly different. This lamp takes one wire from a point where the potential is less than at the positive pole, and takes the other wire from a point where it is greater than at the negative pole. In order that the difference of potential furnished to the lamps may vary as little as possible, both from this cause and by reason of adding lamps to or subtracting them from the circuit, it is clear that the resistances of the mains and the machines should be as small as possible.

Remembering the formula CE, and remembering, too, that in any simple circuit, the fall of potential is proportioned among the resistances, the formulæ follow for the *electrical* efficiency of machines—*i.e.*, the ratio of the energy in the external circuit to that generated.

The most simple case is that of the series dynamo. As the current, C, is the same in the external circuit, the armature and the magnet coils, the efficiency F is clearly

$$\frac{r}{a + m + r}$$

where r is the resistance of the external circuit, a that of the armature, and m that of the magnet coils.

In the case of the shunt dynamo, the current in the armature is equal to the sum of the currents in the external circuit and the magnet coils, supposing the shunt to be taken direct from the brushes.

Let A = current in armature, then current in main circuit =

$$\text{A}\,\frac{m}{m + r}$$

and the whole resistance of the circuit

$$\text{R} = \frac{mr}{m + r} + a$$

$$\therefore \text{F} = \frac{\left(\text{A}\,\frac{m}{m + r}\right)^2 r}{\text{A}^2\left(\frac{mr}{m + r} + a\right)} = \frac{m^2 r}{a\,(m + r)^2 + m^2 r + mr^2}$$

The case of a dynamo whose field-magnets are wound partly in shunt and partly in series is very similar.

It is obvious that the formula for the proportion of energy consumed in the external circuit plus that consumed in the series coils (supposing the shunt to be taken direct from the brushes) may be obtained from the above formula by simply substituting r' for r in which r' equals the added resistances of external circuit and series coils.

$$\therefore \text{F}' = \frac{m^2 r'}{a\,(m + r')^2 + m^2 r' + mr'^2}$$

Letting r, as before, equal the resistance of the external circuit alone, we have

$$\text{F} : \text{F}' = r : r'$$

$$\text{F} = \frac{\text{F}r}{r'}$$

$$\therefore \text{F} = \frac{m^2 r}{a\,(m + r')^2 + m^2 r' + mr'^2}$$

In the case of transmitting power from one point to another, the amount of energy consumed in the wires becomes a most important consideration. This energy appears in the form of heat, which is not only lost for all practical purposes, but which has the further effect of raising the resistance of the wires which, in turn, causes the absorption of more heat.

Evidently, as we are to give power to the wire, we wish to know in what form it is most economical to give it, in

order to reduce this loss in transit to a minimum. Power being composed of the two factors, C and E, is it better to make C and E large? A casual inspection of the formula $\frac{E^2}{R}$ might lead to the hasty conclusion that it were better to generate as low an electromotive force as possible. But this conclusion would manifestly be incorrect, for the reason that this would necessitate a large C in order to produce to requisite power; and we all know that heat in any circuit varies as C^2. The formula, it need not be said, however, is correct, for here E means not the whole electromotive force, but only that fraction thereof represented by the ratio of the external to the whole resistance. Thus we see that we must get R as small as possible, because, although E diminishes in the same ratio, yet E enters by its square. We also see that the whole resistance as compared with R must be great. In other words, we must use a machine with considerable resistance generating a high electromotive force, and conductors of small resistance. Thus we clearly get a small C.

It is to be observed, however, that in cases of power distribution, other considerations may have weight.

It may be desired, for instance, to transmit power during the day by the same company which supplies incandescence lamps by night. In this case it would probably be found more economical to use the same wires and to supply motors in multiple arc, than to have a separate system supplying them in series. The greater safety of a low tension current is, moreover, a most powerful consideration.

In applying the formulæ

$$C\,E \text{ or } \frac{E^2}{R} \text{ or } C^2R,$$

care must be taken to remember that as C indicates the quantity of electricity passing in one second, these expressions indicate not work, but the amount of work performed in one second. In order to get the work, we must either multiply the expression representing the energy by the time during which that energy was furnished, or else we must find the number of coulombs passing in the time. Thus we see the rationale of the Edison meter. The indicator shows the number of coulombs which have passed; and as the potential is kept nearly constant, this indication furnishes a measure of the work which has passed through the subscriber's wires. In other words, the subscriber does not pay for the amount of electricity furnished, but for the work performed.

In conclusion, it would seem pertinent to suggest that it is not well to have the same unit, the erg, for both energy and power. Almost every issue of the English ELECTRICAL REVIEW contains communications from persons who, from that cause alone, seem to hopelessly confound electrical energy and power.

ELECTRICITY AS A MOTIVE POWER.

By Prof. GEORGE FORBES.*

THE subject of the transmission of power by electricity has been so often discussed in this room, that I have had some difficulty in selecting the point of view from which I should look at the subject to-night. I presume that most of my audience have seen the action of a current which was generated by one dynamo acting upon another dynamo so as to cause it to rotate. I presume that they have also seen such a motor driving a circular saw, or a fan, or a sewing-machine. They may also have heard of the grand possibilities among which the imagination delights to revel, on the realisation of which we shall look back on the old life without electricity as being but one step removed from barbarism. I propose to myself something more humble, but, perhaps for all that, quite as useful. That is, to discuss the results which have been already attained, and to show what steps are immediately possible with the knowledge and experience now at our disposal. I will not weary you with descriptions of machines, nor refer to their relative merits. In quoting the performance of any special machine, it will not be so much on account of its merit, as because it may have come more especially to my notice in connection with the particular subject which I may be talking of.

Of course, from the moment that Oersted discovered the action of a current on a magnet, it was known that energy could be transmitted to great distances by a wire. The energy which is put in at one end of a telegraph cable is partially reproduced thousands of miles away, in the form of mechanical movement. But what we have to consider is, the condition of using a current to supply motive power to drive machinery. In what cases is such an application practicable, in what cases is it economical, in what cases convenient? I wish to give you, this evening, an answer to these questions, and to explain what has been done and is being done in this field; how far we can build on past experience, and how far we are justified in foreseeing steps in the future. When new discoveries are made, we are distrustful of them; but we are too often, also, apt to be oversanguine, we dive, in our imaginations, into the future, and conceive that that immediately will be accomplished which experience ought to warn us can only be the result of many decades of labour.

Let me give you an example. We are constantly hearing at present of a certain method by means of which water-power, it is said, will be extensively used. This is to use it in charging accumulators with electricity, and then to carry the accumulators on a tramway or railway, and use them to drive the waggons. At first sight this seems very feasible, but reflection makes us pause. The same water-power has been always available; it might have been used to compress air; compressed air tramcars have been constructed, and, in my opinion, are a perfect success. This method of application of the water-power is much simpler than by the electrical accumulators. But it has not yet been tried, and hence we cannot hope that this method of using electricity is likely to be very soon introduced.

From the time that it was known that a current of electricity, in going through a wire round a rod of iron, converts the iron temporarily into a magnet, inventors have been at work trying to utilise this knowledge in the construction of motors. The chief difficulty lay in the very short distance through which the attraction of a magnet remains powerful. There was also, in the motors of old date, a difficulty of getting over the dead points. The length of pull of a magnet may be considerably increased by various devices. A somewhat similar action may be effected by utilising the suction of the current through a coil of wire upon a rod of iron. A coil of wire with a current through it acts as a magnet. One end of it attracts the N end of a magnet. But the coil also magnetises a rod of soft iron placed in this position, and having magnetised it, it attracts it.

This principle has been utilised directly to obtain power from electricity. The most interesting application of it which I have seen, was at the Electrical Exhibition at Munich last year. That exhibition was especially of interest owing to the various applications of electricity as a motive power, and I shall have occasion to refer to it more than once. The machine to which I now refer is designed by M. Deprez, and is called an electrical hammer. It is intended to perform the same functions as a steam-hammer. It consists of a vertical tube containing a short rod of iron, and surrounded with a coil of wire. The wire at each turn is led away to a contact piece on a plate with a moveable switch. By this means, the current passes only through fifteen turns of the wire. But there are one hundred turns of wire altogether, and by moving the switch you can pass the current through any fifteen you please. You suck the iron into one section, and then move the switch, and so raise the centre of attraction. In this way you suck the iron up to the top of the tube, and then you can equally well drive it down, with the force of suction added to the weight of the iron. The weight of the iron was 80 lbs., the height of the tube one metre. I can illustrate the principle with this model. He used a current of about 36 ampères; 31 ampères was found sufficient, when passing fifteen times round, to support the weight of the iron. The length of the iron rod was about six times its diameter. This is equivalent to saying that, in such a coil, a current of one ampère must circulate (15×30^2), or 13,500 times, to support the iron rod in the centre. I tried independently with this small coil, which has three layers of 43 turns each (129 in all), and I found that five ampères were required to support the iron in the centre. From this result one ampére would have to make 16,200 turns in place of 13,500, as Deprez found. I give these data because they help to fix our ideas, and numerical measurements in magnetism are far more scarce than in electricity. Dr. Werner Siemens has used the same principle in the construction of a motor to be driven by electricity, though I need hardly say his invention was not derived from the one just mentioned. It will readily occur to you that the electrical hammer of M. Deprez might, by a simple modification, be converted into a reciprocating motor, like the piston of a steam-engine, and so it might be used to drive a fly-wheel and machinery. But in this mode of applying it, the whole of the momentum of the iron mass would be lost at the end of each stroke. The same is true of the piston of a steam-engine. But in the rotary-engine it is not the case. Now, although the rotary-engine is not so economical as other steam-engines, its principle serves to lead us from the electrical hammer of M. Deprez to the beautifully ingenious electric motor of Dr. Werner Siemens. If we suppose the tube with the coil of wire round it to be bent round into a circle, the iron cylinder being also bent into an arc of a circle, then, by changing the points of contact for the current to pass through the coils, we could suck the iron core round and round inside the circular tube. This is the principle employed by Dr. Werner Siemens in the elegant motor which he has lately produced. The inner iron core is made in the form of a complete ring, but only a certain arc is of iron, the rest is of brass. It rests on wheels, spaces being left in winding the coils for these supports to reach the central ring. In the actual machine, the points of contact for the current to enter and leave the coils are changed automatically by the rotating ring. In such a form of motor the magnetism of the iron is never changed or destroyed, and this diminishes largely the waste of energy by heating during magnetising and demagnetising, which is so serious an objection to most motors—I think I might safely say, to all other motors.

If this form of motor were used to drive machinery, it is easy to see that, instead of making contact automatically, it would be quite easy

* Read before the Society of Arts, Wednesday, May 2nd.

to do so by hand, simply turning a handle round; and by doing so more or less rapidly, the speed of the machinery might be regulated by a boy with most perfect facility. It could be quickened, slowed, stopped, or reversed by the simple process of turning the handle. I consider that there will be a great demand in the future for such a form of motor. I will give one example. I am sure many of my audience will sympathise with me when I speak of one of the horrors of a sea voyage, I refer to the terrors of the steam-winch. What traveller has not spent sleepless nights under the constant influence of the whirring and jarring of that dreadful engine when stowing or discharging cargo. For many years I have felt convinced that this was a field for the application of electricity as a motive power. But for a long time no scheme suggested itself to me which was perfectly satisfactory. In fact, it was not until I saw Dr. Siemens's motor that I felt satisfied that the thing could be accomplished. I have no hesitation in saying that such a motor, with the contacts made by hand in the manner I have described, will be a very perfect machine, and very much more easily managed than the present steam-winch, with its troublesome combination of valves and brakes of multiplying and reversing gear. When such machines are introduced, life on board ship will be a different thing.

Now, I am not going to spend time to-night in describing all the different motors which have been invented. Most motors now in use are simply generators of electricity used in a different way. Many years ago, after a prolonged absence from England in the Pacific, I was writing to the late Professor Clerk Maxwell, and asked him what had been going on in science during my absence. His answer was, "the greatest discovery of late years is that a Gramme machine can be reversed." He saw that this must be a more perfect type of electro-motor than any previous one, and that now there was a real future for employing electricity as a motive power. The Gramme machine was a cheap generator of electricity, and was an efficient motor. The problem was solved, and only required development. Of course, Professor Clerk Maxwell's remarks would have applied to any other of the modern generators. I am not going to trouble you with a description of these machines; their construction is known to most of you. It suffices to say that, when one machine is turned so as to give a current, it can drive another machine at a distance.

Now let me say a few words about the convenience of electrical motors. We are certainly a long way from having electricity laid on to our houses, like water, which we may use for any purpose we please. But when it is laid on, it is certain that many people will use it, because they now use water engines, although water is very expensive, and because electric motors would be far more convenient in many ways. But in a large factory, the only methods available for distributing power is either by shafting or by steam-pipes. Both of these are objectionable in many ways, and the convenience of having only to lead wires to the different places where power is required, will in time become manifest to many of our manufacturers. This remark applies more especially to donkey-engines and steam-steering apparatus on board ships; and I confidently look forward to electricity being largely used for the light work on steamers, and this before any long time. Of course, special attention will be given to see that the compasses are not affected by the powerful magnets and currents used for these purposes.

It is found that to get any good effect an electric motor must run at a high speed. In this there is a great difference between the theory of electro-motors and of steam-engines. If a steam locomotive were restrained from running down an incline by the pressure of steam on its piston, the steam would be doing no work, and no power would be used up, except by a slight condensation. But if an electric locomotive were to perform the same office, it would be using up the current all the time, and yet not performing external work. When with the electrical hammer the iron cylinder is supported in the tube by the electric current, power is being used up and yet no external work is done. It is the same as with muscular exertion. This introduces us to a new factor in mechanics, the cost of the statical effort. When I support a weight, I am using up muscular energy, and yet I am doing no external work.

But there is one peculiarity in electric machines of great importance. The motor is also a generator. Thence it follows that, when it is in motion it creates an electromotive force. This tends to produce a current of electricity in the circuit, going in the opposite direction to the one which is driving the motor. The intensity of this opposing force is directly proportional to the velocity of rotation. If the generator and motor were identical, and the work done by the motor was so far reduced as to allow it to rotate nearly as fast as the generator, then the opposing electromotive force would almost be equal to that of the generator, and there would be hardly any current in the circuit. But if a brake be put upon the motor, more work is done, and the current in the circuit increases. The maximum amount of work is got from a motor in this way when the counter-electromotive force is equal to half that of the generator. The greatest efficiency (or return) is obtained when the counter-electromotive force is nearly equal to that of the generator. Some persons have argued from this that we ought to run motors with very light loads for the sake of economy. This is not the case. If the motors were run so as to do only half of the maximum, we should require twice as many motors, and usually the prime cost of the motors is too great to cause this to be economy. The efficiency of a generator for electric lighting or other purposes is highest when there is a very high resistance in the circuit, but electricians, as a matter of fact, nearly always work their dynamos up to their maximum capacity, although this is by no means the most economical so far as the efficiency is concerned.

I have said that, to produce a good mechanical effect with a dynamo used as a motor, it is necessary to drive it at a high speed. This speed is generally too great for ordinary mechanical applications. For example, we do not require the wheels of a tram-car to turn at anything like a speed of 800 turns a minute. In such applications, then, it becomes necessary to reduce the speed by suitable gearing. Thus, in the electrical tram-cars which have been constructed hitherto, belting has been used, or some equivalent. This is an awkward expedient, and one which, in practice, is found to give much trouble. I am inclined to think that in making an electrical railway, it would be preferable to make the wheels of small diameter and attached directly to the axle of the motor. This seems to be by far the best plan in the present state of affairs. It may be that a motor will be found which will work economically at a lower speed; but with those which are now at our disposal, it would be best to work with very small wheels.

We now come to consider, directly, the transmission of energy to a distance. There are two separate kinds of application. One is to fixed motors, the other to locomotives. Let us begin with the stationary motors. There is no doubt that if electricity be capable of transferring the water-power of rivers to the centres of mechanical industry, if it be capable of introducing economy by burning coal at the pit mouth, or the bottom of the pit shaft, then we have a vast engineering industry ready to open out.

It is not until we have sat down and worked out from experimental data the cost of installation and maintenance, that we can pronounce an opinion on the merits of such schemes. When we want to send a large quantity of energy to a distance, through a thin wire, we must use the highest electromotive force which we consider safe, and the most powerful current which the conductor will bear without either fusing or injuring its supports by heating, and then we have no means of increasing the amount of energy which we can send, except by increasing the size of our conductors. Unfortunately, when we double the weight of our conductors, we do not double the current which we can pass through them. Hence there must necessarily be a limit to the quantity of energy which can be sent along a single line, which limit is reached when the cost of the conductor becomes too great. When a limit is thus attained, the only way of increasing the transmission of energy economically is by increasing the number of systems of conductors, or else by introducing means of cooling the conductors. These are the considerations which have guided M. Deprez in his experiments. But Sir William Thomson has shown that the loss of horse-power in heating the conductor more than compensates for the expense of thicker conductors. For economy, we ought to have the value of horse-power thus wasted equal to the value of interest and depreciation of conductors.

In such an installation we require to consider not only the quantity of power which can be be transmitted, but also the efficiency of the arrangement. Now the efficiency varies with the quantity of power which is transmitted. If we transmit very little energy, we get a high efficiency, nearly = 1; if we transmit the maximum amount of energy possible, the efficiency is $\frac{1}{2}$. In fact, the work done by the motor is proportional to the efficiency, minus the square of the efficiency—

Where $w = 4\text{M}(e-e^2)$.
M = the maximum work possible.
e = the efficiency.
w = the actual work returned.

And consequently, when the efficiency is nearly equal to unity, the work done is zero. It is found in practice to be preferable to get nearly the maximum work out of a machine, rather than to increase the size and cost of the machines, in order to get a certain amount of work from the apparatus.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph Engineers and of Electricians.

AN ordinary general meeting of this society was held on Thursday, May 10th, Mr. Willoughby Smith, President, in the chair. The minutes of the last ordinary general meeting having been read and confirmed, and the list of new and proposed new members read, a description was given by Mr. J. H. A. MACDONALD, Q.C., Associate, of his "Electric Holophote Course Indicator," for the prevention of collisions at sea. Mr. MACDONALD commenced by saying that there was no calamity so destructive of human life as a collision at sea, and the liability of such collisions to occur was increasing every day, partly in consequence of the increase in the number of vessels and partly in consequence of the high speed at which steamships were driven, whilst the extreme length of the vessels rendered their handling difficult. Steamships are now propelled at a rate of 22 miles an hour, and two ships running at this rate would approach one another with a relative velocity of 44 miles in 60 minutes—and would, if distant about 2 miles, come into collision in about $2\frac{1}{2}$ minutes. As the velocity was so great it was of the utmost importance that notice should be given as quickly as possible by one vessel to another of their proximity. At present this was effected by means of the well-known red and green lights, the red being on the starboard and the green on the port side of the vessel. With this arrangement, however, it was impossible to tell in what direction the

vessel was steering, and some more efficient means in which a powerful light was employed was very desirable. A powerful arc light affords the means required, and electricity enables the mechanical control of the light, at a distance from the same, to be carried out effectively. The apparatus which Mr. Macdonald brought forward to the notice of the society consisted of an arc light with a strong reflector behind it. This reflector could be moved so as to direct the beam of reflected light either to the right or to the left, but this movement could not be effected if the helm were amidships, as the reflector under these conditions was locked in its central position. If, however, the helm be turned in one direction or the other, then the reflector can be turned so as to indicate by the movement of the beam of light the direction in which the ship was steering; but as a mere side to side movement would obviously not afford the required information, a shutter was connected to the reflector in such a way that when the beam had completed its side movement the shutter rose up and obscured the light, and did not drop again until the reflector had been turned back to its middle position. A similar action took place whether the reflector were turned to the right or to the left hand. In order that the helmsman might be able to tell when the reflector had moved sufficiently to either side to cause the shutter to rise to its required height, an electric bell was connected to the apparatus which sounded when the necessary angular movement was completed; a second bell indicated when the reflector was turned back to the middle position, at which position the shutter dropped again. An addition which had been recently made to the apparatus consisted of an automatic whistle attachment, which by means of two whistles of different notes indicated the position of the helm.

A paper was then read by Professors W. E. AYRTON and JOHN PERRY on "Electromotors and their Government."

Professor AYRTON commenced by saying that the fact that wires had been successfully laid underground pointed to the possibility of electric force being supplied by such wires for workshop purposes, &c. Electric motors possessed the advantages that their weight, compared with the horse-power they could give out, was comparatively small; they enabled power to be easily transmitted to a distance, and this with a small wire only. They also enabled high velocities to be obtained by direct action. Two of these points, viz., transmission to a distance, and high velocities were important to Londoners, since they enabled the Underground Railway to be ventilated by means of a number of fans set at different places along the tunnel, and all driven by a prime mover. Portability and light weight were important features in electric motors. Professor F. Jenkin's system of telepherage depended on these to a great extent. Numerous experiments had been made by the authors on the efficiency of existing motors, the results being as follows:—

Dead weight of motor, including stand.	Useful Horse-power given out.	Efficiency.	Name of motor.
Lbs.			
2·5	·0266	17 per cent.	Griscom
8·03	·062	20 ,,	Gramme armature, with Siemens' field magnet
20·9	·014	3·7 ,,	Jablochkoff
30·8	·123	26 ,,	Gramme armature, with Siemens' field magnet
	·0745	32 ,,	
36	·25	30 ,,	Ayrton and Perry
72	·75	50 ,,	De Meritens
75	·70	49 ,,	Ayrton and Perry
519	5·6	71 ,,	Siemens
	4·95	75 ,,	

From these results it will be seen that that the power per pound of dead-weight increases somewhat with the weight, whilst the efficiency increases immensely with the weight. In making these experiments, various precautions were adopted in order to enable the results to be as accurate as possible. The greatest amount of work and the greatest efficiency that can be got out of a motor is that which would be obtained with the greatest current possible consistent with the wires not being abnormally heated. Although it has often been stated to the contrary, the current *does* depend on the load, and also on the speed of the machine. The Jablochkoff motor is an example of the wrong way to make such a machine; one great defect in it consisted in the existence of the inclined ring; the quick rotation of the latter placed a severe strain on the spindle, and produced excessive friction.

On an average one horse-power could be obtained from every 100 lbs. weight of the motor, though this proportion was greater in the heavier machines.

Professor AYRTON then described various governors which he and Professor Perry had devised for the regulation of the speed of electromotors. The best form which suggested itself was that of a break which stored up the surplus power, but how to effect this was the question. Now it is well known that dynamo machines when rotated at a low speed do not give any current, but at a certain speed (called the *critical* speed) the current can be produced. This current mounts up very rapidly as the velocity is increased; advantage has been taken by the authors of this fact for the controlling of electromotors. The problems to be solved were the production of a constant current such as would be required when lamps are joined up in series, or a constant electromotive force as when lamps are joined up in multiple arc. If the motor consists of an armature revolving between the poles of a permanent magnet, then under ordinary conditions the machine would not be under regulation; but if one of the poles were wrapped with convolutions of wire in circuit with the main current, the connections being so arranged that the current tends to weaken the magnetism of the permanent magnet, then the speed of the armature becomes regulated. Such an arrangement would be adopted with motors joined together in multiple arc. For a series arrangement the current from the main circuit was split, a portion going through the armature and thence through a thick wire coil round the field-magnets, the other portion passed round a thin wire coil also wound on the field-magnets. By having the thick coils adjusted to the required "critical" resistance, its demagnetising influence did not become effective until a certain speed was reached; but at this point the influence increased very rapidly with the speed, and thus by the field-magnets becoming demagnetised the speed of the motor became checked.

Professor PERRY then continued the paper by dealing with the theory of the question. In dynamos and motors there is a considerable increase in the resistance of the machine when it is running, this increase varying directly with the speed. Hitherto this had not been taken into account. Professor Perry then considered the question of the relative sizes of the armature and field-magnets in an electric motor, and as a result of calculations the conclusion arrived at was that the field-magnets should weigh but one-tenth of the field-magnets and armature together; this value, however, from the fact of self-induction existing, required to be considerably reduced. Actually, the armature should be about twice as heavy as the field-magnets; and this could be conveniently arranged in a machine by fixing the armature and making the field-magnets revolve. The brushes in both dynamo and motor machines, it was pointed out, are usually wrongly arranged, as a forward lead ought to be given to them beyond their usual position. This was proved experimentally by a machine in which the armature rotated in one direction when the field-magnets were excited and in the reverse direction when the wire on the field-magnets was cut out of circuit.

At the conclusion of the paper, after a few remarks by the President, the meeting adjourned.

Physical Society.—MAY 12.

Prof. CLIFTON in the chair.

New Member—Mr. A. W. Soward.

Mr. WOODWARD described "An experiment illustrating Motion produced by Diffusion." A porous reservoir of clay containing air was suspended from one end of a weighted balance beam. A glass tube projected from it below and dipped into a vessel of water. A jet of hydrogen gas was allowed to play on the outside of the reservoir, and the balance beam began to oscillate. This is an adaptation of Graham's well-known experiment, and is, in fact, a diffusion engine. Prof. ADAMS explained the action by the variation of pressure in the reservoir set up by diffusion.

Mr. W. LANT CARPENTER read a paper on "Some Uses of a new Projection Lantern." This lantern, of German make, is supplied by Mr. Paterson, and is simple in construction, cheap, and gives a good image visible to a large audience. It can be used with a three-wick oil lamp or the lime light. Mr. Carpenter showed a number of objects on the screen. Mr. LECKY and Mr. WOODWARD offered some remarks, the latter deprecating a too frequent use of projection with students. Dr. C. R. ALDER WRIGHT read a paper on the "Electromotive Force of Clark's Mercurous Sulphate Cell and the work done during electrolysis." He described the best mode of constructing Clark's standard cell. According to numerous tests, these cells vary in E.M.F. about 0·2 per cent. + or − among themselves. A cell properly made will keep its value for about two years. It is of great importance that the cell should not be worked or the current reversed through it, otherwise it may permanently deteriorate. The extraction of air from the paste is not very essential, and boiling it is unnecessary. It is more important that the solutions of zinc sulphate should be saturated. Dr. Wright described a cell in vacuum, which is a good standard. He found the E.M.F. to vary 0·4 per cent. between 0° and 100° C. With regard to the work done in a cell, among other interesting deductions, he found that in a secondary battery, the larger the plates the greater the economy. In the electrolysis of water the greater the surface-condensing power of the electrodes for gas, the less difference of potential is required to decompose the water. Thus with platinum electrodes a lower E.M.F. serves for the electrolysis than with gold electrodes.

Prof. FOSTER then took the chair, and Prof. CLIFTON read a paper on a "Complete Determination of a Double Convex Lens by lineal measurements on the Optical bench." This was a method (somewhat similar to that of Mr. Boys previously described to the Society) for determining the four quantities of a lens on the bench by lineal measures and without the use of the spherometer and prism. Experiment showed that it was about as accurate as the spherometer method.

A NEW FORM OF BATTERY

FOR PRODUCING AN INTENSE, CONSTANT CURRENT OF LONG DURATION.

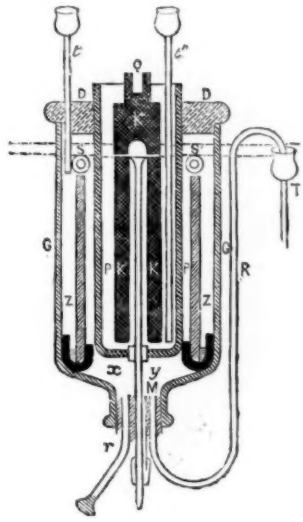
IN endeavouring to obtain a battery furnishing an intense, constant, and enduring current for making his experiments upon his movable bobbin galvanometer, Dr. E. Obach invented and constructed the battery represented by the sketch, which is reproduced from *Carl's Repertorium*.

This battery is nothing more than a Bunsen battery: zinc, sulphuric acid solution, carbon and nitric acid arranged so as to insure the continuous renewing of the liquids. The mean internal resistance of each element is 0·07 ohms, and the electromotive force 2·09 volts; it furnishes therefore nearly 30 ampères on short circuit.

GG is a bottle 20 centimetres in height and 12·5 centimetres in diameter, placed in an inverted position upon a suitable support; the bottom of it is cut off and replaced by a wooden cover coated with paraffine. The porous pot, P, of red earthenware, supported by a cork ring, is 23·5 centimetres high and has an internal diameter of 6 centimetres.

The choice of the porous pot is very important, as the satisfactory working of the element depends largely on its quality. The porous pots employed by Dr. Obach were entirely saturated one minute after being filled with water, which is a good test of their porosity.

The porous potis closed by a plug saturated with paraffine, which is penetrated by the square end of a carbon, K. This block of retort carbon is 22·5 centimetres in length and 3·5 centimetres in diameter; it is perforated in the centre by a hole 15 millimetres in diameter and 18 centimetres in length. It is perforated at the top with a series of small radiating holes; a glass tube, M, of which the extremity is slightly funnel-shaped, reaches to the top of the carbon and penetrates the porous pot and the plug of the bottle. The bottom of the porous pot is paraffined, as well as its upper part and the head of the carbon. Upon the bottom of the bottle rests a gutta percha ring, x y, in the form of a trough, filled with mercury, in which dips the lower portion of the zinc cylinder, which is 16 centimetres high, 6 millimetres thick, and weighs 2 kilogrammes. Two tubes, R and *r*, pass through the plug at the lower part of the bottle and of the two cupped tubes in the cover *t'* and *t*; *t* reaches to the upper part of the zinc, and *t'* to the bottom of the porous pot.



The liquids circulate thus:—

Fresh nitric acid enters at the bottom of the porous pot by the tube *t'*, whilst the spent acid runs off by the radiating holes at the top of the carbon into the central tube, M, and into a receptacle placed below. Fresh sulphuric acid solution enters, on the contrary, at the upper part through *t*, and, rendered more dense by the formation of sulphate of zinc, flows by the siphon R into the tube T. The surface of the liquids is nearly even, as is seen by the dotted lines in the figure, the sulphuric acid solution being at the highest level. S S' is the section of a glass tube of circular form arranged at the upper part of the liquid, where there is most heat; this tube is traversed by a current of cold water for maintaining the liquid at a constant temperature. The tube *v* serves to empty the battery; it is always closed during its action.

All the connections are made by mercury contacts. The zinc cylinder is connected to a sheet of copper enclosed in a glass tube which penetrates the cover and dips into the mercury in the gutta percha trough upon which the zinc cylinder rests. The square end of the carbon is hollowed at O; the cavity thus formed is filled with mercury, which serves to establish communication with the external circuit.

The inventor describes means of mounting two or several batteries, as well as a mercury commutator allowing of the coupling of the elements as required.—*La Nature*.

Transmission of Mechanical Work by Electric Currents.—M. H. Tresca, Member of the Académie des Sciences, Paris, on Wednesday held a conference at the Société d'Encouragement pour l'Industrie Nationale, when the following subjects were considered:—Source s of Mechanical Work; Various Modes of Transmission of Mechanical Work; Mechanical Work Developed by Electric Currents; Electrical Transmission of Mechanical Work; State of the Question and Results of Experiments; and Various Conditions of Application. This conference, of which we shall give an account, will present a special interest from the fact that M. Tresca is a member of the commission nominated by the Académie des Sciences to examine the experiments of M. Marcel Deprez at the Chemin de Fer du Nord. We know that the report, of which we gave a complete analysis three weeks ago, presented a certain number of obscure points, upon which the conference will perhaps be more explicit than the commission.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Letters respecting Advertisements, Subscriptions, &c., should be sent to the "Publisher," ELECTRICAL REVIEW, at above address.

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CORRESPONDENCE.

Permanent Magnets v. Electro-Magnets.

To many who have studied the construction of the numerous systems of machines for producing electric currents, it must have been difficult to see why the original plan of using permanent (natural) magnets for the field magnets was abandoned, and why electro-magnets have now almost universally been adopted. However, in the dynamo machine of De Meritens permanent magnets are still employed, and the excellency of its results shows that the advantage gained by electro-magnets is somewhat problematical.

In regard to this question, it would be interesting to know what proportion of the total power expended in working ordinary dynamos is consumed in exciting the electro-magnets, both in self-exciting machines and those using a separate exciter. It seems to me that the whole of the expense of the power used by the exciters might be saved by employing permanent magnets, which do not require any expenditure of power on this account. So far as I know, the existing text books do not give any information in regard to this point. That most excellent permanent magnets may be and are made is shown by the following table, which gives the carrying power of magnets of different sizes, the smaller ones being proportionately the stronger.

Weight of magnet in kilog.	Carrying power in kilog.	Weight of magnet in kilog.	Carrying power in kilog.	Weight of magnet in kilog.	Carrying power in kilog.	Weight of magnet in kilog.	Carrying power in kilog.
0·5	11·5	6	69	16	133	30	202
1·	21	7	76	18	144	35	224
1·5	27	8	84	20	154	40	245
2	33	9	91	22	164	45	265
3	43	10	97	24	174	50	285
4	52	12	110	26	184	60	321
5	61	14	122	28	193	—	—

I should feel exceedingly obliged if one of your many contributors would enlighten me on this point, which I think is not unimportant.

Permanent Magnet.

Correction.

In your article on the installation of the electric light at the offices of the Electrical Power Storage Company, you state that the electroliers were made by "Messrs. Benjamin Verity & Sons, of Stanhope Street, Euston Road." As this is likely to do us considerable harm and lead to much inconvenience, we shall be obliged if you will state in your next issue that the firm is Verity Bros., and not Benjamin Verity & Sons, as they have no connexion with us whatever.

Benjamin Verity & Sons.

Covent Garden, *May 12th*, 1883.

Tests of Incandescent Lamps.

In a recent number of your valuable journal you published a table of tests of various incandescent lamps. Will you allow me to add the following and more recent tests of incandescent lamps:—

Tests of 15 "*Gatehouse*" *Lamps.*

AVERAGE PER LAMP.

Resistance cold	=	96 ohms.
Current	=	1·05 ampère.
E. M. F.	=	49 volts.

TOTAL FOR 15 LAMPS.

Current	=	15·5 ampères.
E. M. F.	=	49·0 volts.
$\frac{759·5 \text{ watts}}{746}$	=	1·018 H. P.

This result, I venture to say, is unparalleled, and shows a very important advance in electric lighting, giving nearly 15 lamps of 20 candle-power for one H. P. I am aware that good results have been obtained with one or two lamps when burning at a high candle-power, but those results cannot be compared with such as I now send you, where the current is divided into a number of lamps.

In contrast with eight lamps of 16 candle-power for one H. P., with which we were content a few months back, and more recently 10 lamps of 20 candle-power, the "Gatehouse" lamps show an extraordinary increase in efficiency.

I would point out that such an advance is a very hopeful sign for the future of electric lighting, and there is a prospect of still better results. It is daily becoming more evident that the many advantages in favour of the electric light and its decreased cost must lead to its universal adoption.

Henry F. Joel.

London, N.W., *May 12th*, 1883.

[If our correspondent's tests were accurately taken the results shown are extraordinarily high. We should be glad to know what instruments of measurement Mr. Joel used, and would suggest that he should repeat his tests by the method recommended by us in the ELECTRICAL REVIEW for July 1, 1882, p. 475.—EDS. ELEC. REV.]

The Long-Distance Telephone Company (Limited).

The directors in the prospectus of this company published by them, soliciting subscriptions and shares in this undertaking, say "the original patentee, Hopkins, to take out patents for the following countries: France, Germany, Austria, Russia, Italy, Belgium, Holland, Spain, Portugal, Sweden, Norway, Denmark, Turkey, Danubian Principalities, Egypt, &c., India, Australia, Nova Scotia, South America, Canada, Mexico, and the whole of North America, with the exception of the United States, thus constituting this organisation a parent company."

To the best of my knowledge no patents are granted in Holland, Turkey, Egypt, or India. I may be in error, and I hope the directors will inform the public as to how they are to obtain patents in those countries which they include in the property to be purchased by the company for the trifling sum of £200,000.

I believe it is the law in France and Belgium that a patent for an invention cannot be obtained in either of those countries after a patent for the same invention has been issued in any foreign country. Will the directors inform the anxious public (who subscribe for their shares) how they

will obtain patents for the Hopkins telephone, already patented in the United States and Great Britain?

I respectfully ask the directors to inform the public how they can deliver to the company the patents for the countries named when no patents are granted, and what position they stand before the law in offering for sale and receiving money for a property which has not and cannot have any existence?

Common Sense.

Long-Distance Telephoning.

In your Review of 12th inst., you were pleased to publish "a communication received by the United Telephone Company from the general manager of the American Bell Telephone Company," and you remark thereon that "it will be seen from this that with any of the instruments at present used, partial conversation at times could be carried on over a distance of 1,000 miles, but this was due to the conductor solely, as we have already pointed out."

I also have communications from the United States, extracts from which I shall quote to show that this puff by the United Telephone Company of the "ordinary Bell receiver" is an incorrect statement in that "the most satisfactory tests resulted from the use of a double Edison transmitter with an ordinary Bell telephone." My correspondent at New York, who is a gentleman of high standing and experience in telegraphic and telephonic matters, wrote me on 26th March last as follows:—

"Various telephones were tried, among them the Blake transmitter with the ordinary Bell telephone, with very unsatisfactory results. Nothing intelligible was got through."

"Another, called the Hopkins telephone, made of a carbon plunger immersed in mercury, could be heard but with breaks and irregularities, while the secret telephone was equally unsatisfactory; the cork or molecular being the only one which gave reliable and perfectly satisfactory results."

"The conversation was perfect, almost free from induction," and "we were all astonished at the perfection of the articulation as well as its loudness." On March 29th my correspondent wrote, "The electrician of the Postal Telegraph Company, who own the compound steel copper wire, says that the Lockwood-Bartlett instruments, thus far, are the only ones that have proved satisfactory." On April 3rd, my correspondent wrote, "A test of the Lockwood-Bartlett telephones took place to-day, between New York and Chicago, about 1,000 miles, in the presence of a large number of persons, and was a decided success. We not only were able to maintain a conversation, but could distinguish the voice of the speaker." "The induction was nothing on the L and B receiver, compared with what it was on the Bell receiver, which latter was so noisy as to destroy articulation." I append an account of a trial of the molecular telephone, published in the *Chicago Times*:—"A test was made yesterday, between this city and New York, of Professor Waite's new molecular telephone. The Chicago end was at the Union stock-yards, and in New York at 49, Broadway. A large gathering of interested persons met in room 41 of the Exchange buildings at the yards to witness the operation. Among those present were A. B. Pullman, Colonel Abner Taylor, F. W. Mowbray, John B. Drake, Warren Leland, Isaiah Block, W.O. Cobb, Professor Barrett (City Electrician), L. D. Parker (Western Manager of Postal Telegraph Company), and Duncan B. Cannon (Western Agent for the Molecular Telephone Company of New York). Professor Waite was in charge of the experiments. Six of his improved receivers were strung on insulated wires in such a way that six persons could sit around the room and listen to the conversation carried on with the New York parties. When all was ready, Professor Waite opened with that very common expression, 'Hello!' and the listeners heard a faint voice repeat the remark, but not so distinctly as could be wished. After some difficulty in getting the New York end to understand, it transpired that they were using an Edison transmitter, instead of, as at this end, a Waite molecular transmitter. This was remedied, and a marked improvement was at once apparent, and the conversation continued in this strain: 'Do you get me now?' 'Yes; I want to talk to Colonel Taylor.' 'He's just gone out to see a friend.' 'When will he be back?' Depends on the number of friends he meets." "Is Mr. Pullman there?' 'Yes.' 'Ask him if he has any stock to sell.' Mr. Pullman expressed his determination to hold on to all his stock."

It seems to me that your opinion that this successful talking through 1,000 miles was due to the conductor *solely* partakes somewhat of rashness.

The actual resistance of the wire used was 1522 ohms, that of best iron wire used on the same circuits was about 6,000 ohms; these figures represent the total resistance of the line, leakages included, not the resistance of the metal conductor alone.

I have made numerous trials of the L. and B. telephone through resistance coils with three cells medium Leclanché, and have carried on conversation perfectly well through a resistance of 25,000 ohms. If, then, a line of best iron wire 1,000 miles long will present a resistance, leakage included, of 6,000 ohms, or of average iron wire a resistance of 15,000 ohms, leakage included, can it be said, on theory, that the success over the 1,000 miles was due to the *conductor solely?* I submit that before such a judgment be accepted a trial on ordinary telegraph wire should prove or disprove the correctness of your opinion based on theory.

In regard to long-distance telephoning on ordinary telegraph wires, from 20 to 50 being suspended on the same poles, during the time when telegraphing was at its height, I submit the following report of trials made with the Lockwood-Bartlett telephone on July 13th last on the telegraph lines of the Baltimore and Ohio railroad:—"1st trial, Baltimore to Harper's Ferry metallic circuit, 96 miles; 2nd, Baltimore to Cumberland, 193 miles; 3rd, Baltimore to Grafton, 294 miles; 4th, Baltimore to Parkerburg, 399 miles. In each and every trial conversation was carried on with perfect success by the general manager and several of the higher officials of the Baltimore and Ohio railroad, who expressed themselves amazed at the distinctness of articulation and clearness with which every word was conveyed."

The above report was made by Mr. Waterbury, a gentleman well known in New York.

W. C. Barney.

May 14th.

[Mr. Barney should know that a resistance coil of 25,000 ohms used for a laboratory test is entirely different to a telegraph line, and his experiment is therefore of no value whatever. We have ourselves in the early days of the Bell telephone, received articulate speech through a much higher resistance than that specified by our correspondent.—Eds. Elec. Rev.]

Dynamo-Electric Machine Patents.

Seeing no answer to the above headed query in a recent issue, I should direct your correspondent to the British Museum Library, where he can inspect the number of "Il Nuovo Cimento," which contains a description of Professor Pacinotti's Dynamo Machine, published in 1860.

I hope, however, at some future time to forward you a note on the subject.

A. E. Conti.

London, *May 14th*, 1883.

Electrical Distribution.

The editorial observations appended to our letter, which you were good enough to publish on the 12th inst., call only for a brief notice on our part, seeing that they contain no arguments.

You confine yourselves to stating that we have failed to show that our "system is anything other than the use of induction coils, pure and simple, but of special construction."

Our secondary generators are, in a sense, induction coils; but their special construction enables results that have never yet been attained by any of the apparatus with which you class them under the generic and somewhat misleading term of "induction coil." They are therefore new."

It is needless to revert here to the arguments advanced in our previous letter with the view of showing that our apparatus is really constructed on a principle absolutely different from that employed either by Mr. Fuller or by Messrs. Thomson and Houston, since you meet those arguments by bare assertion; and assertion in matters of science is not argument.

The conditions of the experiment you propose we should make with a Spottiswoode induction coil as a means of testing the value of our "metallically" closed circuit would not be applicable, because they could never be present in our system of distribution. In effect, we cannot imagine any one with arms sufficiently long to touch the circuit simultaneously at any two points where the difference of potential would permit the body to be traversed by a perceptible current.

When asserting that our calculation concerning the 40-light Brush machine is "utterly fallacious," you must yourselves have overlooked the important fact that the size of the wire on the armature (induct) of such a dynamo machine would not admit of its carrying even a 20-ampère current without being rapidly deteriorated.

We are quite willing to think that your remarks were not made in mere disparagement, and trust you will kindly find space for this rejoinder.

Lucien Gaulard.
J. Dixon Gibbs.

May 15th, 1883.

[When tests of Messrs. Gaulard and Gibbs' scheme have been made by competent authorities their pretensions will probably be settled. In regard to touching a circuit in two points, we should not imagine extra long arms necessary if the two wires ran side by side. It is not necessary for us to say any more regarding this matter.—EDS. ELEC. REV.]

Electrical Measurements.

In your issue of 5th instant you publish a letter from Mr. Purnell in reference to mine of 5th March last, inserted in your number of 10th *idem*.

In reply, I beg to state that I have tried the method, shown in fig. 1 of my letter, with an ordinary bridge, but never with one of the slide-wire pattern. As I have not access to my notes just now (they are in far-off Persia), I am unfortunately unable to give numerical examples, but the results that I had obtained were always to be depended upon. I had not, however, been long using this method when I modified it, as shown in fig. 2, and ever since I have employed the modification, and with the best results, in which I am glad to see that Mr. Purnell's experience bears me out.

My fig. 1 is correctly drawn, so that I can only account for your correspondent's inability to bring his galvanometer to zero by supposing some inconstancy in the E. M. F. of his batteries. In the case of the single cell, this would result from its polarisation by the larger battery if left too long under its influence. I ought, perhaps, have put Mr. Purnell on his guard against this by quoting the concluding paragraph of my letter of July 5th, 1875, which is as follows :—

"I need hardly remind your practical readers that in order to avoid polarisation of the weaker battery by the stronger, the connection of the two should be momentary *until* balance of the galvanometer needle is obtained.

"I may, however, mention that the internal resistance of a battery (or it may be its E. M. F.) in a closed circuit, and whose positive-plates are 'dirty,' is very variable. True, this variation is generally small, but it must not be neglected, for, since it makes R a variable quantity—which *may* alter during the second part of the test—E must also be variable to a proportionate extent. When, therefore, great accuracy is aimed at in determining the electromotive force of a battery, care should be taken that the positive-plates are clean, and that their immediate surroundings contain no metallic substance (in solution or otherwise) foreign to the plates themselves."

J. J. Fahie.

May 12th, 1883.

Electrical Exhibitions.

Having read huge advertisements of the "Great Electric Exhibition" and "Blaze of Light" at a West-end establishment called the Royal Aquarium, I accompanied some scientific friends to behold the latest improvements and discoveries in that branch of science to which some of us devote our little existence.

Both my friends and myself wandered from end to end of a most deplorable building, sadly in want of paint and whitewash, seeking rest to our inquiring minds, but finding none; the only evidence of electricity being the lamps, which in many cases remained dark, and in others gave a "fitful glare," while in odd, out-of-the-way corners some full-size engines struggled wonderfully with some very undersized dynamos, and a waxwork exhibition seemed to have alighted on the renowned Ferranti, as an attendant kindly assured us "it used to stand" at a certain place, "but the waxworks had been set atop of all the things at that end."

Electrical appliances were confined to a few incandescent lamps in rooms of furniture, with advertisements of dealers in useful and ornamental household requisites, and a more utterly forsaken and deplorable "Scientific Show," it is impossible to conceive. Sixpenny shows of marvellous monkeys, fourth-rate conjurors, acrobats, and a street Punch and Judy, are provided to add to the attractions of science, and give a HIGH-CLASS ! ! ! entertainment. I failed to see that such an affair is beneficial to science, or likely to add to the brilliancy or dignity of yours truly,

An Electric Spark.

Electrical Accumulators.

In the *Daily News* of the 12th inst. a telegram appeared from their special correspondent at Vienna stating that "the day previous the electric light was tried at the Opera House there with complete success; 200 accumulators fed 1,236 lamps distributed all over the theatre."

Since then I have had many communications pointing out that this telegram showed the existence of a successful rival accumulator.

May I, therefore, beg you to be kind enough to announce that the complete success arrived at in the Opera House in Vienna was achieved by Faure-Sellon-Volckmar accumulators constructed in that city by Mr. Lewis Volckmar, one of our electrical engineers, under the auspices of the Anglo-Austrian Brush Electrical Company, Limited?

J. M. Collet,
General Manager, Electrical Power Storage Company, Limited.

London, *May 15th*, 1883.

Metal Microphones.

We were unable to be present at the reading of Mr. Munro's paper on Telephone Transmitters at the Society of Telegraph Engineers, else we might have had something to say concerning metal microphones when that paper was discussed.

When we read the report of that discussion we were somewhat surprised to find that one of the principal participants in it made no mention of the fact that he had seen and tested a metal microphone which was perfectly successful, although it had only two points of contact.

We were about to supplement the discussion already published by a communication to the above-named society, when we found that Professor Sylvanus Thompson, whom we have not the pleasure of knowing personally, and who is not "interested" in our transmitter, had to some extent done so himself, and we therefore allowed the subject to drop.

Mr. Munro, however, now transfers the discussion to the ELECTRICAL REVIEW, and states his views in a manner which we cannot let pass unnoticed.

Will you, sir, therefore kindly allow us a little space in your valuable journal, to reply to Mr. Munro's letter.

Mr. Munro, to the best of our knowledge, has never seen our transmitter, and, to judge from his letter, we should say he has not even read the specification of our patent. His magisterial condemnation of our transmitter (which is quite as much the result of invention and experiment as his own) and his sneer at our "patent" is therefore, to say the least of it, a little premature. Mr. Munro does not seem even to dream of the possibility that his gratings and gauzes have been experimented with before him by other parties, but were relinquished for something better. Yet such is the case, and to paraphrase Mr. Munro's own sentence, *we* (and probably others who have experimented much in this direction) have no hesitation in saying, as the result of experience, that such microphones will not be practicable

transmitters for any length of time, owing to the impossibility of retaining that nicety of adjustment which alone can produce anything like distinct articulation.

We quite agree with Mr. Munro when he says that the distinction between our "elementary" metal microphone and his "complex" one makes all the difference between a practical and an impractical instrument, only we call the "complex" one the impractical instrument.

If it be difficult to keep one pair of contacts in good condition, what would it be to keep the 50 pairs so, which Mr. Shelford Bidwell recommends and Mr. Munro considers necessary! Now, as a matter of fact, Mr. Munro does *not* obtain "numerous" points of contact by his arrangement. It is practically impossible to make two pieces of wire grating touch one another at a great many points *at one and the same time*. We should say they never so touch one another at more than three points, but that these points are continually shifted about the area of the grating when the latter is vibrating. It is therefore to be quite expected that the grating of the transmitter should be reproduced as a "grating" articulation in the receiver.

We do not, however, wish to enter into a controversy with Mr. Munro, but simply to refute that part of Mr. Munro's letter wherein he implies that we have only "patented" but never worked, only experimented but never succeeded with our metal microphone. Now, it is an absolute fact that one of our metal transmitters, with only two pairs of contacts (we never have made one with a single pair), has been in constant use for the past 14 months, and now works as perfectly as when we first tried and showed it, in March, 1882. We believe Mr. Preece will, if asked, kindly inform Mr. Munro whether that trial was a perfect success or not.

In spite of all theories and "conditions," the contacts in our transmitter never stick, the points do not burn or waste away, simply because there are *no points*, and the whole arrangement never requires any adjustment whatever. Our transmitter has, therefore, passed the experimental stage long ago, and compares favourably with any carbon transmitter now in use.

Can Mr. Munro make the same assertion concerning his own transmitter? We are quite willing to afford him the opportunity, and shall be glad to put up one of our instruments by the side of one of his for a comparative test, say of one month, on the sole condition that the cases of both instruments be locked during the whole of the time.

R. and M. Theiler.

Metallic Microphones.

In your last issue I noticed a note from Mr. Munro in reference to a communication from Professor Silvanus Thompson read before the Society of Telegraph Engineers, which referred in some paragraphs to Mr. Munro's metallic transmitter and receiver.

Having for some time been experimenting on the nature of contacts of different substances with a view to find something like a practical solution of the problem of reviving weak undulatory currents to their initial magnitude by means of combined local currents without altering the nature of the undulation to any degree, I have, through a series of experiments, found some phenomena, which to a certain degree appear to me to occur in every form of contact of various form and substances, either homogeneous or heterogeneous. In reference to the nature of contacts in general, I shall be pleased to lay before your readers the little I have learned about them in the course of my experiments and what I have gathered from the previous experiments of others.

After some meditation on the subject I have tested by experiments the following apparent phenomena, which seem to hold good in general.

1. *If the current passing through a contact is increased, the two faces repel one another.*

2. *If the same is decreased the reverse happens.*

3. *Every current, however small, passing through a contact causes a certain degree of cohesion, which in the case of metals may be regarded as fusion of the projecting particles.*

4. *A current passing through a contact generates on the opposing faces a polarity inverse to its own, i.e., an electromotive force which tends to resist its passage; this is more apparent with homogeneous contacts.*

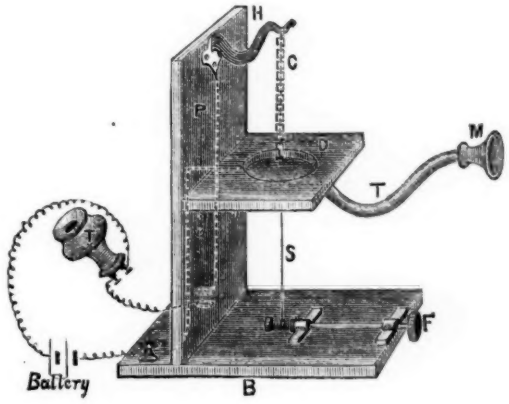
5. *A circuit formed of a number of contacts in series gives, on removing from the circuit the principal electromotive force, an extra current of longer duration than if made of a perfect continuity with equal resistance and length.*

6. *With a constant distance between the faces, the initial resistance of contacts varies inversely with the current.* This, of course, is independent of the variable resistance of the rest of the circuit, which for metals varies direct with the current through thermal effects.

7. *There is found no contact which on varying the pressure on it does not to some degree produce undulatory currents.*

8. *There is found no absolute contact except through fusion and amalgamation.*

The simplest form of instrument which I have found to answer for the purpose of testing the attraction and repulsion of contacts is as shown by the following diagram. A fine iron chain, C, is suspended from a hook, H, fixed to an upright wooden board, F, about two feet high. The lower end of the chain is fastened at the centre of a round disc, held round its edge under a perforated board, D, by a wooden cup, forming the "camera sonora," which is connected with a short pipe, T, and a mouthpiece, M. A fine silk thread, S, fastened underneath the disc, enables the tension of the chain to be regulated by means of the thumb head, F. A telephone and battery is inserted in circuit through the chain on disc. When the instrument is properly adjusted it acts either as a receiver or transmitter, though I must say that for this purpose its adaptation is very limited. A multiplying lever (not shown in the diagram) applied at the centre of the disc for deflecting a mirror (as in Stroh's apparatus) shows faithfully the repulsion and attraction.



Whatever novelty this may bear in connection with the testing of contacts, the idea of using a chain for showing the imperfect connection in contacts is a very old one and can be traced back from a century ago. Nicholson, in his "Introduction to Natural Philosophy," in vol. ii., page 332, gives, in reference to the use of chains as conductors, the following paragraph, which for the sake of convenience I have thought it convenient to transcribe:—

In discharging electric jars the electricity goes in the greatest quantity through the shortest course. Here is a crude law on shunts deduced from electrostatic experiments.

Thus, if a chain and a wire communicating with the outer coating be presented to the knob of a jar the greater part of the charge will pass by the wire and very little by the chain, which is a worse conductor, by reason of its discontinuation at every link. When the discharge is made by the chain only, sparks are seen at every link, which is a proof that they are not in contact, and as the chain must be stretched by a considerable force before the sparks cease to appear on the discharge, it follows that there is a repulsive power in bodies by which they are prevented from coming into contact unless by force, as has been observed in the former part of the treatise.

Now, returning to the main point in view, I would say a few words in regard to Mr. Munro's metallic transmitter and receiver.

There is no doubt that the instruments shown before the society possess some interest and are not without novelties. The two papers read on the 8th of March last did not fail to attract the attention of the sceptical electrician. Without endorsing in "*extenso*" the view therein set forth, I must say I share a good part of them.

The historical hints drawn in the first paper, though very neat and concise, in many respects they open wide subjects for discussion.

The question of "*who is the first inventor of the telephone transmitter and receiver*" is a very complex one and has on more than one occasion aroused the attention of the scientific world.

It is not for me to attempt to decide a question which has engaged the special attention and faculty of eminent jurists and experts, but nevertheless I may be allowed to express my humble opinion from a point of view without falling into the law's labyrinth.

To an impartial electrician it must appear clear that the telemusic instrument of Reis stands at the bottom of all telephonic instruments, just as Volta's discovery stands as the foundation-stone of the great electro-dynamic edifice.

Though considering these great discoveries, we cannot forget the consecutive discoveries and inventions made by others upon these, consequently the honour of a perfected branch of science does not rest entirely on him that opened the entrance to a new channel, but is also shared by those who have explored it, and found others, new minor channels, though, of course, the first will be entitled to the largest share.

Graham Bell's discovery constitutes in itself a new branch, having at the root the discoveries of Faraday and Reis. But it would be absurd to attribute to Bell the discovery of transmitting music and speech by undulatory currents (as it has been claimed), though he may have discovered another way for doing that. *We cannot make a contact that does not produce undulatory currents to some degree by varying the power of cohesion.* Reis's instrument works with undulatory currents and not by make and break, as it has been supposed. As a mere fact, it would be a very difficult task indeed to produce high notes, whose pitch may be two or three thousand vibrations per

second, by successive make and brake; consequently, as Reis's instrument transmits and receives music, *i. e.*, a compound of pitches of various strength, it follows that, having the property for passing from a high pitch to a low one with different amplitude, in fractions of time imperceptible to our senses, it possesses also the requisite for transmitting and reproducing articulate speech.

But perhaps Reis was not aware of all the good qualities with which his instrument was gifted; then, he who has discovered them has also a right claim for a share.

It has been said that Reis used platinum points for contact, and considered the cleanness of contact as essential for the working order of his instrument.

But let me say that Reis having chosen a sharp metal point for one of the points of contact, he could not have done otherwise than to use platinum or iridium points, since no other metal would have stood long enough for making a satisfactory experiment.

Being a supporter of the arc theory, I should say in regard to the cleanness of points that, having only one point for the course of the current, all the tension being concentrated upon a small area, the particles of matter carried from the positive to the negative point, and also those resulting from the decomposition of the medium accumulating together, must naturally, after some time of action introduce in circuit an extra resistance, which calls forth an increase of electromotive force in order to bring the instrument to its primitive condition; hence, here, the preference of keeping the contact clean for obtaining that end.

The perfecting of the Reis instrument by Elisha Gray was a good stepping-stone for the success of Bell and Edison.

After the Bell's publication in 1876, which threw a flood of light over the Reis-Gray instrument, it was a comparatively small task indeed to construct a "*tension regulator*," *i.e.*, an instrument which is the combination of the two.

The patenting by Edison in 1877 of his tension regulator, together with all known semi-conductor substances, and those "yet to be discovered," was more a speculation than a scientific discovery.

The compressed plumbago contact produces the same phenomena (with greater amplitude) as a platinum or an iridium one, with the sole advantage over these latter that once adjusted it stands for a longer time without readjustment; but this advantage is more to be attributed to the relative volume of the substances used than to the relative quality. Then it was from 1861 to 1877 that the principal discoveries for transmitting and receiving speech and music were made.

But while considering the importance of these discoveries we cannot forget the successive inventions made since 1877 by other inventors, which only resulted in adding advantages to those who already owned patents with broad if not exaggerated claims.

The invention of Professor Hughes in 1878 was a great simplification of the so-called tension-regulator and of the Reis-Gray transmitter; yet Edison asserts to have written a letter (early in 1878) to Mr. Preece, describing therein confidentially the modification made to his tension-regulator by substituting in place of plumbago two loose pieces of carbon, and that he believes the latter communicated confidentially the idea to Professor Hughes, all of which is contradicted by Mr. Preece.*

"Of course the validity of such an assertion and contradiction is better known to the contending parties, and perhaps it is very wrong of me to mention it."

The President, after reviewing the discussion which followed the reading of Mr. Munro's papers, said:—"*Whatever the theory of the microphone may be, there is no doubt that to Professor Hughes belongs the honour of having invented the instrument and giving his discovery to the public.*" Proceeding, he said:—"*I have often felt sorry to see in print that Mr. A. or Mr. B. has invented a microphone, but I hope that in future we shall never hear such instruments mentioned except as modifications of Professor Hughes's microphone.*"

However right this may be it is no doubt very exhilarating, and is no less open for discussion, since all inventions (except a few original discoveries) are undoubtedly modifications of previous modifications of some original discovery; just as the microphone, or whatever name it might be called, is undoubtedly a modification and a great simplification of a previous transphone from an original telephone.

The microphone not being considered as an original discovery, any one that invents a complicated transmitter does not copy the features of the microphone (whose chief qualities of perfection is simplicity) unless he should use carbon contacts; but rather from the tension regulator, and if metallic contacts are used it is more from Reis's than from any other, though he may study other instruments for gathering experience to his advantage.

I have great respect for Professor Hughes for the many useful discoveries and inventions he has made and given philanthropically to the public, yet for all this I am not prepared to realise the idea that he is "*the man of all men*," as some one called him, since in my humble opinion I believe "*the man of all men is men, and not a man.*" The mere fact that one is not too far unknown to the other greatly diminishes the validity of such a hyperbolical denomination. Since the invention of Graham Bell many modifications and simplifications have been effected by various inventors, and I believe all genuine ones deserve a right of merit after the wearing of brains of their respective perfectioners.

Returning to Mr. Munro, I will say that I share what he said in regard to the theory of his instruments, but I must say that the "*silent discharge*" which he propounds has in my opinion no meaning whatever when taken as the base for studying the nature of contacts.

The arc as the base for a theory is in my opinion the more correct of all, as far as our present knowledge goes.

The heat theory appears to me to be very evasive and no less inconclusive, it being analogous to an attempt to explain the propelling action of a locomotive by saying it moved by heat! Of course, we all know that where there is an electric current there is also caloric due to it; but how far the heat is involved in the peculiar action of the contact remains yet a mystery to be revealed.

Perhaps the safest way for a cautious scientist to avoid at some future date being found in error is to put forth an ambiguous theory.

In my opinion a theory which when propounded is not readily explained ought to be rejected entirely, since "*what we do not fully understand ourselves we should not attempt to explain to others.*"

Apologising for having taken up so much of your valuable space,

A. E. Conti.

* See *Engineering*, June 28, 1878, page 518.

LEGAL.

The British and Irish Telephone and Electric Works Company (Limited.)

THE petition of Mr. J. Gaskell for the winding up of this company was to have been heard before Mr. Justice Pearson, in the Chancery Division of the High Court of Justice, on Friday of last week, but it was agreed, at the instance of Mr. Giffard, Q.C., that the hearing should be held over till after the Whitsuntide recess.

The United Telephone Company (Limited) v. The London and Globe Telephone and Maintenance Company (Limited.)

BEFORE Mr. Justice Pearson, in the Chancery Division of the High Court of Justice, on Friday of last week, Mr. Cozen Hardy, Q.C., obtained leave in this action to serve notice of motion for the first motion day in the sittings after the Whitsuntide recess.

The United Telephone Company (Limited) v. The Long Distance Telephone Company (Limited.)

ON Friday of last week, in the Chancery Division of the High Court of Justice, Mr. Theodore Aston, Q.C. (with whom was Mr. Moulton), moved that the defendants be restrained, until the trial of the action or further order of the court, from manufacturing, selling, letting for hire, or using magneto telephone transmitters or receivers manufactured according to the manner described in the specification of certain letters patent dated December 9, 1876. Mr. Macnaghten, Q.C., on behalf of the defendants, offered to do nothing in contravention of the notice of motion until next motion day, but refused to withdraw the prospectus from publication. After some discussion this was agreed to, the undertaking to be without prejudice to any question.

The British Electric Light Company (Limited), v. The Anglo-American Corporation (Limited).

In the appeal court of the High Court of Justice, on Friday of last week, Lords Justices Cotton and Bowen delivered judgment in this case, which was an appeal by the defendants from the Divisional Court, for the security of the costs of the action. Lord Justice Cotton said the application was founded on the 69th section of the '62 act, and from that section it was obvious that the burden rested on the defendants of proving that the assets of the plaintiffs were insufficient to pay the costs of the action. Affidavits had been put in to the effect that the shares of the British Company, were to a considerable extent paid up, but that there was an arrear of calls, and that one person believed the company had no assets or property available to pay their trade creditors, but no grounds for that belief were given; also that the company "are very bad payers, and that people to whom they owe money have to call many times before they can get payment." That did not at all show, however, that the company had not the money to pay the costs. Many people who had money were unwilling to pay their debts. It was also said that the British Company were carrying on the action by the aid of funds supplied by the shareholders of the company and others. The court gave the plaintiffs an opportunity of filing an affidavit in the matter, and, although they denied the statement that they were unable to pay the costs, and also the statement that the action was being carried on by money supplied by the shareholders, they did not state what the value of their property was, or what their debts were; but they denied that they had no assets available to pay their trade creditors, or the costs of the action. They had, they said, property which would be available for the costs of the action, to say nothing about the debts; and in an application of that kind a company was not bound to go into a detailed statement of the valuation of its property. Under the circumstances he thought the court ought not to come to the conclusion that security of costs should be given. The appeal in his opinion ought not to be sustained, and the costs of the appeal, he considered, should be put in the costs of the action. Lord Justice Bowen, without comment, concurred.

The Consolidated Telephone Construction and Maintenance Company (Limited).—In reply to numerous inquiries, the secretary of this company states that his directors are advised that the new shares recently issued will rank, *pari passu*, with the old shares now quoted in the official list.

NOTES.

Electric Lighting.—The Jablochkoff Electric Light and Power Company (Limited) has secured permission from the Strand District Board of Works to apply for a license for the whole of the District under the Board's authority, which comprises the five parishes of St. Ann's, Soho, St. Paul's, Covent Garden, St. Clement Danes, St. Mary-le-Strand, the Liberty of the Rolls, and the Precincts of the Savoy. The Vestry of St. Mary-le-Bone has also granted the Company permission to make application for a license for an important section of its district. Among the installations of the Company in progress are those of the Gaiety Restaurant, part of the International Fisheries Exhibition, and the Aston Lower Grounds, Birmingham.

A deputation of the Bootle Town Council, having lately visited the works of the Electric Carbon, Storage and Apparatus Manufacturing Company of Scotland (Limited), Leith, and inspected and investigated its system of electric lighting, the Watch Committee of the Council has now instructed the surveyor to prepare a sketch of the Town Hall, to be sent to the company, with a request for an estimate of the cost of lighting the building by electricity.

In Committee of Supply of the House of Commons on Thursday of last week, on the vote to complete the sum of £37,110 for the Houses of Parliament, Mr. Shaw Lefevre, answering several members, said he did not think that at present electric lighting was a proper subject for competition. After examining the various systems made public at the Paris Exhibition and at the Crystal Palace, he came to the conclusion that the Swan system was the one best adapted for lighting the Law Courts. The last company which ought to object to his selecting the Edison Company to light the Houses of Parliament was the Swan, which in like manner he had selected with respect to the Law Courts. He believed there was very little difference between the Swan and the Edison systems. Perhaps the noble lord, (Lord R. Churchill), was connected with the Swan Company. Lord Randolph Churchill said he was neither a director nor shareholder in the Swan Company, but that company had made superhuman exertions to complete the lighting of the Law Courts in time for the opening, and had given great satisfaction. What they and other companies complained of was—personally he had no interest in any company—that the First Commissioner should have concluded arrangements with a Yankee adventurer, without the English companies having an opportunity of tendering. Considering the gambling that took place on the Stock Exchange in the shares of these companies to a very large extent, he thought that the Government should have been more careful before giving the Edison Company such an advertisement as lighting the House of Commons. Mr. Shaw Lefevre said, with respect to the noble lord's observations on Mr. Edison, he might say that Mr. Edison was above all suspicion of the character mentioned. The vote was agreed to. Mr. Arnold White, of the Edison Electric Light Company, in a letter to the editor, in Monday's issue of the *Times*, in reference to the above discussion, writes :—"The word 'adventurer' can be understood in two senses, but it is evident that the member for Woodstock intended to stigmatise Mr. Edison as a person in search of fortune, and unscrupulous as to the means by which it was obtained. As a friend of Mr. Edison, I deny this imputation, as being absolutely without one particle of foundation. Mr. Edison is not only a gentleman well known to the world, as possessing the highest reputation and character, and of the most distinguished scientific attainments, but these attainments have hitherto produced him, as far as I know, more fame than fortune. I think he can afford to despise such a statement made even by Lord Randolph Churchill. He is not aware, evidently, that the Edison Electric Light Company is not a public Company with a quotation of its shares on the Stock Exchange, and consequently that no gambling in its shares could take place on the Stock Exchange, as suggested by his lordship. Lord Randolph Churchill stated that he was neither a director nor shareholder in the Swan Company. Will the noble lord be good enough to state that he has not accepted the chairmanship, nor given the shareholders to understand that he will accept the chairmanship, of the Incandescent Company (Limited), at Birmingham, in alliance with the Swan Company (Limited)?"

Several of the large factories in Devonport dockyard are about to be lighted by electricity.

A most successful exhibition (about the first of its kind in India), says the *Bombay Gazette*, of April 24th, was made last evening at the shop of Messrs. Treacher and Company, Bombay, by the Eastern Electric Light and Power Company. About fifty of Swan's lamps were employed to illuminate the extensive premises. Twenty secondary cells of two horse-power each are required to work the lights in Messrs. Treacher and Company's establishment. The principal charging stations of the Eastern Electric Company are at Mody Bay and Tardes, and they have run underground cables in various parts of the city, so that connections with houses and places of business might be made whenever required. The bungalow of Major Strutt, the managing director, situated on Cumballa Hill, has for some time past been lighted on the incandescent system with great success, and the experiment has proved that the light combines efficiency with economy. Yesterday's exhibition was witnessed by many of the public, and it gave great satisfaction to all. The Company believes that the light only requires time to gain popularity, which it would not be surprising if it did, under such an energetic manager as Major Strutt, and such an efficient electrician as Mr. Grindle. From the *Times of India* we learn that the band-stand and several other places in the city, including the Esplanade Parade Road, the Marine Lines Road, and the neighbourhood of the Queen's Statue, are to be lighted with electricity. The electric lighting of the High Court has been delayed pending the settlement of the arrangement about the lighting of the Esplanade. Two tenders were received—one from Major Strutt, managing director, Eastern Electric Light and Power Company, and the other from the Indian Electric Light Company. Major Strutt's tender has been accepted by Government, and a contract for three years entered into.

The experimental lighting of the stage of the Grand Opera in Vienna, says a Vienna paper, took place before a large audience of invited guests, including Prince Hohenlohe, Count Kinsky, Count Larisch, Baron Hofmann, Director Jahn (manager of the Burg Theatre), and many ladies and gentlemen from both the Court theatres. The installation consisted of 1,236 incandescent lamps, fed by 200 accumulators, and was put up by the Anglo-Austrian "Brush" Electrical Company (Limited). All the experiments went off without a hitch, and with the most perfectly equable distribution of light, obtaining the congratulations of all present, including several influential Viennese experts.

On Monday evening the premises occupied by Mr. John Duncan, ironmonger, Union Street, Aberdeen, were lighted by Lane-Fox incandescent lamps; the needful power being supplied by Faure-Sellon-Volckmar accumulators. The exhibition was successful and during the evening attracted much appreciative public notice. We understand that the electric illumination of Mr. Duncan's premises is to be continued, and that the Brush Electric Light and Power Company of Scotland, which is conducting the experiment, anticipates shortly to conclude arrangements for the extension of this system to other business places in the city.

The Vienna International Electrical Exhibition.—The Rotunda in the Vienna Prater, the adaptation of which for the purpose of this exhibition will shortly be commenced, has been used several times since 1873 for exhibitions. Its circular design and symmetrically distributed adjoining rooms secure every electrical exhibitor excellent space, accessible from all sides, and its gigantic dimensions allow of the finest display of the electric light. Besides the central building with a surface of 12,900 square metres, there are four transepts and three galleries of 6,750, and two large courts of 6,600 square metres, making altogether a surface of about 30,000 square metres at the disposal of the Exhibition Commission. Comparing the Rotunda with the exhibition palaces at Paris, London, and Munich, we find that in the Palais de l'Industrie at Paris, a surface of 29,264 square metres was employed, of which only 20,368 were situated in the Rez de Chaussée, the remaining 8,896 square metres

being in the second story, whereas in the Vienna Rotunda the total coverable surface is on one and the same level. The Munich glass-palace had in all a disposal surface of 10,048 square metres, not even so much as the interior space of the Rotunda, and about as large a space was appropriated by the Electrical Exhibition in the Crystal Palace, London. The height of the interior of the Rotunda will also allow the electric light to be displayed to the best advantage, for 24 metres above the ground floor of the Rotunda hangs the first, at the height of 48 metres the second, and at the height of 66 metres, the third and so-called lantern-gallery, and it is these galleries that offer a favourable opportunity for placing whole rows of effective lights. The whole forms a closed room of 400,000 cubic metres. The distribution of the electric light is for the present planned in the following way: At the height of the lantern-gallery an arc lamp of 20,000 candle-power will send its light downwards; in the upper smaller gallery will be placed a row of 28 arc lamps of from 2,000 to 3,000 candle-power each; in the lower larger gallery there will be 112 arc lamps, each of about 1,000 candle-power; 36 arc lights of 500 candle-power each will be distributed on the ground floor, and in the 28 arches of the half gallery will be hung 56 arc lamps of 800 candle-power, so that the flood of light in the Rotunda every evening may be calculated at about 265,000 candles. In the transepts, galleries, and courts there will be besides the arc lights, incandescent lamps by thousands. Including the lighting of the adjoining and outer rooms, the passages and alleys, &c., it is estimated that the total power of the lights which will be produced and employed at the Exhibition each evening will be about 600,000 candles, a total which surpasses fivefold the amount of gaslight used in Vienna and its ten districts, which, according to official reports, is 120,000 candles.

Western Counties Electrical Exhibition.—An exhibition of electrical appliances and electric and artificial lighting will be opened in Plymouth in September next. A nominal charge will be made for space, and the committee will use every endeavour to get a large attendance of visitors from all parts. Amongst the patrons we notice the names of Professors Abel, C.B., F.R.S., D. E. Hughes, F.R.S., Sir John Pender, M.P., and W. H. Preece, Esq., F.R.S. Now that this proposed exhibition has been entertained, and the work of organisation commenced, we wish the scheme success; but it is surely time that these so-called electrical exhibitions were put an end to, and some *bona fide* business contracted by those who are so fond of spending large sums of money in periodically bringing forward their systems, which, however, appear never to get beyond the "exhibition" stage.

The Thomson-Houston Electric Company.—The directors of the American Electric Company of New Britain, Conn., with a desire to avoid complications liable to arise from the fact that there are in the United States several "American Electric" or "American Electric Lighting" companies, and also to compliment the inventors, have decided to change the name of the corporation to "The Thomson-Houston Electric Company." The apparatus of this company will alone supply the lighting at the Exhibition of Foreign Nations, to be held in Boston next autumn. The Thomson-Houston system was described in the ELECTRICAL REVIEW for March 31st of the present year.

Portable Electrical Testing Apparatus.—On the evening of the 18th of April, Mr. Woodbury, of Boston, read a paper bearing the above title before the Franklin Institute at Philadelphia. The lecturer exhibited an instrument of his own design, which was fully described and illustrated in the ELECTRICAL REVIEW for Oct. 14th, 1882.

The Portrush Railway.—The following incident is said to have occurred on Siemens' Electric Railway at Portrush. Owing to the fact that as yet only part of the line is furnished with electric conductors, a steam-engine is still used as well as the electric locomotive. A short while ago the steam-engine while drawing its load along the line came to a stand through the accident of bursting a boiler-tube. News of the mishap having been sent to the terminus, the electric-locomotive was dispatched to the rescue, and returned an hour later with the disabled steam-engine.

Communication between Ship and Shore.—At a recent meeting of the American Academy of Arts and Sciences, Professor A. E. Dolbear suggested, as a means of signalling between a vessel at sea in the track of a submarine cable and the shore, that a large plate should be attached to an insulated conductor reaching from the vessel to the bottom, and another plate should be merely submerged. A battery and Morse key is connected, and by interruping the circuit induced currents are produced in the cable which would affect telephones on shore. Signalling from shore to the vessel is accomplished by using a Morse key on shore and a telephone on board the ship.

Callender's Bitumen Core.—Several tests of this core have lately been made by Messrs. Clark, Forde and Taylor. In one of these it is stated that a 50 ft. length of core was suspended with a sag of about 18 in., and a current of 190 ampères run through it. The heat caused by this current soon rendered the insulating material soft, without, however, affecting its elasticity or shape. After about two hours the current was taken off, and the core allowed to cool in the same position. After about 20 hours a short length was cut out of the centre and opened, showing the conductor still in a perfectly central position. Messrs. Clark, Forde and Taylor therefore think that, having regard to its cost, the core is likely to prove well adapted for electric lighting and other similar purposes, as there can be no reason to doubt that its insulating and other properties will be found permanent.

The Charge against M. Philippart.—A telegram from Brussels says that on the 11th inst. the tribunal confirmed the arrest of Philippart.

The Board of Trade and Professor Tyndall.—In the House of Commons, on Friday of last week, Mr. Chamberlain, in reply to questions by Mr. Gibson and Colonel King-Harman, said he would lay upon the table of the House a return of the correspondence between the various authorities, the Board of Trade, and Professor Tyndall, showing fully the state of the case, and what had led to Professor Tyndall's resignation. In the meantime, he might say it was not true that any committee at all had been imposed on the Irish Commissioners of Lights. A committee was suggested, and the three lighting boards were all asked to send representatives to it. They were requested to nominate their own representatives, and they all agreed in doing so. The Irish Commissioners of Lights did make some objection to the composition of the committee, but they now stated that they would abstain from pressing their objections, and had agreed to the suggestion of the Board of Trade to appoint two members to serve on the committee. In the course of these proceedings he had had an interview with Professor Tyndall, and had endeavoured to induce him to serve on the committee, but unfortunately he had not been successful.

Wanted—One of the Resources of Civilisation.—It is a remarkable and serious fact that between the important colony of Mauritius and England there exists no telegraph line and no means of communication except what is furnished by a French mail-boat. In any circumstances this is a state of things that ought not to be allowed to continue; but in the present state of the affairs connected with Madagascar—the nearest neighbour to the Mauritius, and on which it depends for its supplies—the matter is one which demands very early attention.

The Compagnie Internationale des Téléphones.—Chev. Rosenbusch, C.E., Manager of this company, announces the opening, day and night, of the Malta Telephone Exchange at 27, Strada Mercanti. The yearly subscription is £8 to any distances. The Exchange has several branch offices which may be utilised by the subscribers at any time. Chev. Rosenbusch has just received a letter from Sir Victor

Houlton, the late chief secretary to the Government, containing a flattering recognition of the Chevalier's scientific services in the island.

Trade.—It is stated that electric batteries suitable for use under any of the systems of electric lighting now in vogue are going from Wolverhampton to London. Inquiries that portend to good trade in engines for driving electric lighting machinery are being made in the same town.

Cable Repaired.—The Eastern Telegraph Company announces the repair of the Eastern and South African Telegraph Company's cable between Zanzibar and Mozambique, thus re-establishing telegraphic communication with the Cape of Good Hope.

Female Telegraph Clerks and Sunday Duty.—In the House of Commons, on Thursday of last week, Mr. Kenny asked the Postmaster-General whether it was a fact that the female telegraph clerks attached to the Dundalk office were required to perform the entire of the telegraph Sunday duty of that office in addition to the limit of 48 hours per week, as laid down by his late revision; and if so, whether any compensation had been allowed for this extra duty. Mr. Fawcett, in reply, said he had ascertained that the two female telegraphists employed at the Dundalk office worked during the six week days the usual time of 48 hours. In addition to that, each of them worked two hours on each alternate Sunday. They were entitled to extra pay to the extent of two hours a fortnight, and he had given instructions that the amount due to them should be paid. The night work was done entirely by the male staff.

Society of Telegraph Engineers and of Electricians.—The next meeting will take place at 8 p.m. on Thursday, the 24th May, at 25, Great George Street, S.W., when the following paper will be read: "On the Cause of Magnetism," illustrated by experiments, by Prof. D. E. Hughes, F.R.S., vice-president.

Personal.—Lord Thurlow has accepted the chairmanship of the Anglo-American Brush Electric Light Corporation (Limited), and Mr. Herbert C. Gibbs, of the firm of Messrs. Antony Gibbs & Sons, has also joined the board.

The Rival Telephone Companies.—At the Guildhall Police Court on Wednesday, Theodore Torry, manager at the Globe Telephone Company, and William Goodfellow and James Molyneux, two men working under him, were charged by the United Telephone Company, before Alderman Stone, with wilfully and maliciously injuring their wires. Mr. J. P. Grain, who appeared for the complainants, said the United Telephone Company had a large number of subscribers, and enjoyed a large revenue. That company being successful, the Globe Company was started in opposition to them, and hence the conduct of the workmen towards the complainant company. The course they adopted was to tie their wires together with other wire, so that when a current of electricity went through one of them, instead of setting one bell ringing, it would set forty ringing at once. One of the company's lines passed over the Wool Exchange, in Coleman Street, where the Globe Company had offices. They put on the roof of that building, to carry their wires to other points, what was termed a derrick; but the wires of the United Company did not interfere with the wires of the Globe Company, yet, notwithstanding that, they tied up the wires of the United Telephone Company and put them all in confusion. James Reynolds, labourer, said that in the beginning of May, he was in the service of the Globe Company. Several times then he was on the top of the Wool Exchange running wires for the Globe, and Molyneux and Goodfellow were there also. Torry was on the roof, giving orders, witness believed. Molyneux was his foreman. In consequence of orders received, Molyneux on one occasion tied the wires up with another wire in three places, and a current of electricity was put on from the battery room of the Globe and connected with the wires of the United. That would cause a ringing of the bells of the subscribers, and the men had a laugh about it on the roof, as they knew what the result would be. He also gave evidence as to other acts in which the wires had been tied up. Mr. Lewis, who represented the defendants, complained that Mr. Grain had made statements under instructions which circumstances would not justify. The two companies were in litigation in Chancery, and had already spent £30,000 in law costs. He said the case ought not to have been brought before that court, but before the Court of Chancery. The further hearing was then adjourned.

Anglo-General Electric Light Company (Limited).—An extraordinary general meeting of the shareholders in the above company was held on the 30th ult., at the offices, 4 and 5, Three Crown Square, Southwark, when the following resolution, passed at a previous meeting, was confirmed, viz., That the offer contained in a letter dated 9th ult., addressed by Mr. Laing's solicitors, Messrs. Harvey, Oliver, and Capron, to the directors be accepted, that the company be wound up voluntarily, and that Mr. Charles Frederick Reynolds, of 13 and 14, King Street, Cheapside, chartered accountant, be and is hereby appointed liquidator. Mr. Reynolds has also recently been appointed liquidator of the Anglo-Colonial Electric Light Company (Limited).

General Telegraph News.—The final winding-up meeting of the shareholders in this company was held on the 3rd inst.

Change of Name.—The Board of Trade has signified its approval to the name of the Anglo-Austrian Brush Electrical Company (Limited) being changed to the International Electric Company (Limited).

NEW COMPANIES REGISTERED.

Ferranti-Hammond Electric Light Company of Hampstead (Limited).—Capital £100,000, in £5 shares. Objects: To supply electricity for lighting and other purposes in Hampstead and adjoining parishes, or elsewhere in the United Kingdom. Signatories (with 1 share): *F. Ince, St. Benet Chambers, Fenchurch Street; *Robert Hammond, 110, Cannon Street; *S. C. Barker, Woodford Green; *F. H. Bensley, 41, Sydney Street, South Kensington; P. A. Latham, Ealing; C. W. Rock, 71, The Chase, Clapham; W. R. Jackson, 12, Templeton Road, Highbury. Directing qualification, 100 shares; remuneration £1,000 per annum and one-tenth of surplus profits (except amount carried to the reserve fund) above the first £7 per cent. made by the company and available for dividend. Registered 10th inst. by Ingledew and Ince, St. Benet Chambers, Fenchurch Street.

National Company for the Distribution of Electricity by Secondary Generators (Limited).—Capital £500,000, in £10 shares. Objects: To purchase and work inventions relating to electricity or electro-motive force. Signatories (with 1 share each): T. d'Oksza, 8, Rue Taitbout, Paris; J. T. Campbell, 17, Warwick Street, Regent Street; *William D'Oyley, 24, Westbourne Terrace; *H. O. Lewis, 1, Lancaster Gate; J. D. Gibbs, Kenilworth; *Major J. D. Mackenzie, 27, Sussex Gardens, W.; Lucien Goulard, Paris. Directing qualification, £500 (nominal) in shares; remuneration, £3,000 per annum. Registered 11th inst. by Campbell, Reeves, and Hooper, 17, Warwick Street, Regent Street.

William Elmore (Limited).—Capital £240,000, in £10 shares. Registered office, 91, Blackfriars Road. Objects: To carry on business as electrical, mechanical, and chemical engineers, and for such purposes to take over the business carried on by Shackleton Hallett, under the style of "The Electrolytic Company," at Charlotte Street, Blackfriars, and at 16, Galerie d'Orléans, Palais Royal, Paris; also to acquire the business heretofore carried on by William Elmore at 91, Blackfriars Road. The purchase consideration is £40,000 in cash and 8,000 fully-paid deferred shares.

* Signatories whose names are preceded by an asterisk are also directors.

Signatories (with 1 share each): T. Glass, 15, Buckingham Street, Strand; H. J. Wood, 7, Great Winchester Street; J. W. Thomas, C.E., 70, St. George's Road, Camberwell; S. Newman, 97, Penton Place, S.E.; William Bourne, Oxtead, Surrey; G. Cook, Neasden, Middlesex; J. W. Day, 110, Lambeth Road. Directing qualification, £1,000 (nominal), in shares of stock; the first directors are Charles Bath, J.P., F. W. Dahne, T. A. Merten, J.P., and C. T. Ware. Registered 12th inst. by Ware, Hawes, and Wood, 7, Great Winchester Street.

Spanish National Submarine Telegraph Company (Limited).—Capital £500,000, divided into 49,900 shares of £10 each, and 1,000 founder's shares of £1 each. Objects: To establish and maintain telegraphic communication between Spain and the Spanish possessions, and other points on the Atlantic, or within Europe, Africa, or America. Signatories (with 1 share each): *H. O. Lewis, J.P., Lancaster Gate; *J. D. Gibbs, 10, Bolton Street, W.; *T. D. Pillans, 7, Great Winchester Street; *F. Anderson, 85, Gracechurch Street; *T. d'Oksza Orzectrowski, 8, Rue Taitbout, Paris; *F. L. Hutchins, 11, Birchin Lane; *J. T. Campbell, 7, Warwick Street, Regent Street. Directing qualification, 50 shares; remuneration, one-half per cent. on the paid-up capital. Registered 12th inst. by Ashurst, Morris, and Crisp, 6, Old Jewry.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Maxim-Weston Electric Company (Limited).—The annual return of this company, made up to the 4th inst., was filed on the 11th inst. The nominal capital is £172,500 in £1 shares, divided into 100,000 ordinary, 50,000 vendors', and 22,500 patentees' shares. Upon the ordinary shares a call of £1 has been made and responded to to the extent of £99,997 10s., and £2 10s. has been paid on 5 shares forfeited, and the remaining shares are considered as paid up in full. Registered office, 29, Bankside, S.E.

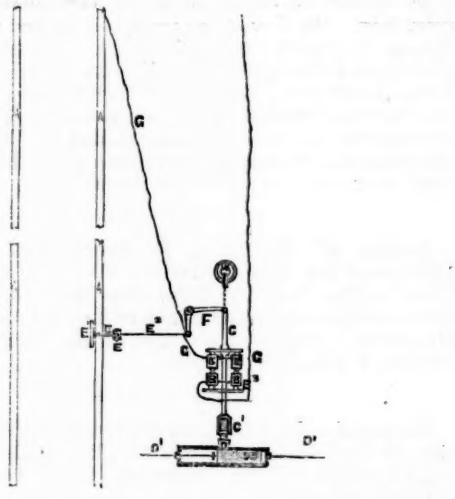
ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

3296. "Preparing sheet lead electrodes of secondary batteries." A. M. CLARK. (Communicated from abroad by Gaston Planté, of Paris.) Dated July 11. 4d. Relates to a process for the rapid formation of the well-known Planté secondary battery, and it consists in immersing secondary cells made of sheets of lead, as usual, in nitric acid diluted with from once to twice its volume of water for about twenty-four hours or longer, before submitting them to the action of the primary current.

4391. "Preparation of plates for secondary batteries." N. C. COOKSON. Dated September 15. 6d. Consists in a method of preparation of lead plates for secondary batteries whereby a very large surface of active lead is exposed to the action of the current of electricity. The inventor prefers to employ in the manufacture of the plates a considerable quantity of lead in a melted state, the considerable quantity being intended to afford facilities for the maintenance of an even temperature in the same, and he uses means so as to regulate a supply of heat during the operation. He has this melted lead in a vessel of such depth as to afford considerable pressure at the bottom, near the bottom of the vessel are made a number of very small perforations, or a pipe is attached having a closed end, or two or more such pipes and the perforations are made in their closed end or ends, and means, are provided from the inside or otherwise whereby the flow of lead through the orifice or orifices described can be stopped at will. It is found that, by due regulation of the temperature of the molten lead and the pressure exerted by it, the issuing streams of lead become consolidated into extremely fine filaments even in moderately cool air. The inventor prefers to gather these filaments on a revolving drum, the speed of revolution of which is regulated according to the speed of formation of the filaments, and the may also arrange the apparatus so as to have the direction of the jet of lead from different orifices interlacing with each other, and he then produces a species of felted fabric of highly subdivided lead at a very small cost.—He consolidates this fabric to some extent, either by pressure, between rolls or otherwise, and then applies and attaches it either to a single sheet of ordinary sheet lead perforated or between two such sheets, or to a series of strips of lead, or by any other convenient means he attaches it to the conducting wires.

4404. "Electric lamps, &c." H. H. LAKE. (Communicated from abroad by S. F. Van Choate, of America.) Dated September 15. 1s. 2d. Relates to electric lamps or lighting apparatus, and to apparatus to be used in connection or in combination therewith, and for other purposes. The object of the first part of this invention is to produce an electric lamp that will give a more steady light than any arc-light of like character now in use, and with less expenditure of electrical energy, and which is at the same time, susceptible of being formed with a higher artistic appearance, and is also free from many of the serious defects of other arc lamps.

4412. "Locking points and signals by electricity." S. BREAR and A. HUDSON. Dated September 16. 6d. The first part of this invention relates to certain improvements in the method of and apparatus for locking points and signals by the train as it passes one signal cabin and unlocking the same when the train passes the next signal box or cabin. Hitherto the signalman has had the responsibility of regulating the trains, but by the introduction of the improvements the responsibility and the liability of the signalman making a mistake is considerably reduced, as the trains themselves, in conjunction with electricity, lock and unlock the points and signals. The fig. represents a diagram plan (not drawn to scale) showing the apparatus employed for locking the signals when worked from the cabin by the ordinary lever system. The letter A indicates the rails on which the trains travel: near to a signal cabin are fixed to the ground in any convenient manner two sets of magnets, B and B^1: the magnets, B, are stationary and B^1 moveable being secured to cross plate and bar, C, the latter of which is made to slide freely through a hole in plate B^2, and finally passes into box, C^1 which contains a spring between the collar on bar, C, and the end of spring bolt, D. When the signal is lowered by the man in the first signal cabin to which the rods, D^1, are connected, the sliding plate is in the position



shown on drawing, and when the wheels of the train pass over the bell crank lever, E, the end of lever at E^1 is pressed down, causing the vertical arm of said lever and rods, E^2, connected therewith to move towards the rails, A, and the long arm of bell crank-lever, F, and rod, C, to move until the magnets, B and B^1, are in contact; and which are kept attracted together by an electric current passing through the wires, G, such current being transmitted from the next signal cabin to which the train is travelling. When the magnets have been actuated in the manner described, the end of spring bolt, D, will press against the sliding plate until the signal be raised, when the sliding plate will be drawn into such position that the hole, D^3, is opposite to the spring bolt, when the latter will shoot into the said hole and thereby lock the raised signal until the train has passed the next signal cabin, where the wheels passing over and depressing a similar lever to E break the electric current, thus allowing the weight, W, to pull the magnets asunder and the spring bolt, D, out of the hole thereby liberating the signal. The invention also relates to the locking of points.

4419. "Electric arc lamps." J. BROCKIE. Dated September 16. 6d. This invention refers to various mechanical devices in the construction of arc lamps, whereby the same may be rendered more simple and less expensive than hitherto, and also efficient in working. Figs. 1 and 2 show points of this invention. The first improvement consists of a dash wheel in order to prevent the too sudden approach of the carbons or the descent of the upper holder. This dash wheel consists essentially of a hollow disc, drum or cylinder, A, mounted on a spindle, B, which is revolved by the descending carbon holder, C; this disc or drum is partially filled with mercury or liquid such as glycerine or oil; or any fine granulated substance may be used. The inventor prefers to divide the interior of the drum or hollow disc into equal divisions by partitions, D, but communicating with each other by small openings at, E; and large ones near the axis at F; he prefers to drive this disc directly by the upper carbon holder, C, by means of a pinion and rack as shown; but it may be driven by a cord or chain or any convenient manner. Now it will be seen that, as the holder, C descends, the wheel will be turned in the direction shown by the arrow and the partitions or divisions will lift the mercury until a balance is obtained; but the mercury will begin to leak back or find its level through the openings at E, and so the wheel will gradually revolve, the rate of revolution depending upon the size of the openings at E, the weight employed and the character

of the mercury or other substance in the drum. The interior of the hollow disc may of course be constructed in various ways in order to obtain a slow movement, or it may even be left quite plain if a very slow movement is not desired or a very light carbon holder is used; but it is found in practice that the construction described and shown

FIG.1

FIG.2

in Figs. 1 and 2 is good and efficient and secures a very slow descent if the carbon holder is of a convenient weight. When mercury is used the hollow disc is preferably made of iron and the cover or lid is fitted very closely to prevent leakage.

4421. "Telegraphic and telephonic apparatus." A. C. BROWN and H. A. C. SAUNDERS. Dated September 16. 8d. This invention has for its object improvements in telegraphic and telephonic apparatus. The improvements are applicable where several "Subscribers" make use of one line wire for telegraphic communication in the manner explained in the Specification of a former Patent, No. 1896 in the year 1882; in this arrangement each subscriber is provided with a step by step instrument in which motion is given by means of a magnet and armature to a wheel and axis. These parts in all the instruments in circuit can be set in motion by currents transmitted by any subscriber and stopped in any required position. The effect of this operation is two-fold, first to establish telephonic communication between the operator and the subscriber to whom he wishes to talk; and, second, to prevent interference by others with the conversation. According to the present invention, in place of transmitting the actuating currents as formerly by successive movements of the operator's plunger or finger key, the inventors produce the current automatically by means of an automatic transmitter which is started by a single current passed into the line when the operator presses his key. The automatic transmitter then sends a series of alternating currents more than sufficient in number to produce a complete revolution in all the instruments on the circuit.

4422. "Telephonic telegraphy." C. A. MCEVOY and J. MATHIESON. Dated September 16. 6d. This invention has for its object improvements in telephonic telegraphy and in apparatus thereof. The well-known Bell telephone is a very efficient instrument for receiving by sound ordinary make and break or intermittent current signals; in portable telegraphs such as are used in military telegraphy it has to some extent been employed. In such telegraphs the use of batteries is inconvenient. Now the improved military or portable telegraph has for its transmitter a finger key operating upon an armature which it causes partially to rotate in front of the poles of a permanent magnet. The armature has coils upon it, in fact it is arranged very much as the armature is in a magneto-electric machine. When the key is put down the movement of the armature induces a current in the coils; this current passes into the line wire and as the key completes its movement the circuit is suddenly opened, the resulting sharp current gives rise to a click in the telephone, and signals given by this key according to the Morse code are readily read by sound. A spring causes the rapid return of the finger key. For military and other purposes it is frequently required to read signals passing in a telegraph wire without making any positive connection with the wire or injuring the insulating material with which it may be surrounded. For this purpose also the inventors employ the Bell telephone; and coupled with it is a case containing a coil of insulated wire. This case is made water tight so as not to be liable to injury by exposure, and it is provided with hooks by which it can be hung against the wire through which the messages which it is desired to read are passing. If these signals be make and break or intermittent current signals they will be repeated by clicks in the telephone and can be read by any operator who is accustomed to read signals by sound.

4429. "Incandescent electric lamp globes." J. CROWDER. Dated September 18. 2d. Has reference to those incandescent electric lamp globes in which the conducting wires are sealed into the glass forming part of the globe itself and the object of the improvements is, 1st, To construct the lamp with as few joints as possible, and 2ndly, To economise labour and cost in its production. (*Provisional only.*)

4431. "Secondary voltaic batteries." A. WATT. Dated September 18. 6d. Relates to the manufacture and arrangement of the material and plates for secondary voltaic batteries, so as to increase the storage capacity of such batteries and to simplify their construction. For preparing the material and plates, the inventor subjects a stream of molten lead to the action of a jet of steam, or of air or other gas which may be superheated, or of a jet of water, so as to disintegrate the lead and carry it forward in the form of spray. He thus produces a kind of lead dust, consisting of rugged granules or fibres, which can be collected in its pulverulent form and compressed into porous plates. Or by placing a board or open framework or a sheet of felt or other fabric in the line of the spray, the lead can be collected thereon in the form of a porous sheet of any desired thickness which can be detached from the board, or can be retained in union with its backing of open framework or fabric so as to constitute a plate to be used in a secondary battery. The plates thus produced or those formed by compression of the lead dust can be strengthened by fusing their edges or "burning" or casting lead on their backs or edges. Instead of using pure lead, an alloy of lead and zinc may be treated as above described, and the plates can then be subjected to the action of an acid to dissolve out the zinc from the alloy, leaving the lead in a more porous condition. Or, instead of using acid, a solution of a salt of lead may be employed, in which case the zinc will be removed and replaced by lead in a spongy condition.

4434. "Galvanic batteries." S. H. EMMENS and S. MASON. Dated September 18. 2d. Relates to galvanic batteries containing fluid electrolytes, and it is designed to obviate polarisation, and to render the current constant and of long duration. The inventors accomplish their object by causing the points of contact between the electrodes and fluids to be changed perpetually, or at suitable intervals, by mechanical means, but in such a manner that the total operative surface may remain of constant magnitude. (*Provisional only*).

4446. "Electrical meters." T. J. HANDFORD. (Communicated from abroad by T. A. Edison, of America.) Dated September 19. 6d. Has reference to the employment of what is termed "an electrolytic motor," in which a body capable of rotation is placed between the electrodes of an electrolytic cell forming part of the circuit between them, and is caused to revolve by the increase of weight occasioned by deposition on the side adjacent to the anode and the decrease of weight on the other side caused by the removal of metal therefrom.

4450. "Porcelain and other insulators." W. E. LANGDON, J. C. FULLER, and G. FULLER. Dated September 19. 4d. Heretofore it has been usual to construct insulators, especially those known as "No. 8," "No. 11," and "Z" insulators with vertical sides, the outside surface being smooth, with the exception of the slot to carry the wire. Now, according to this invention, the inventors serrate the surface with concentric rings, thus obtaining higher insulating properties; they also for the same purpose provide increased space between the bolt of the insulator and the point at which the wire is attached, viz., on the crown instead of on the side of the insulator as hitherto. The serrations perform a double duty, firstly, in still further increasing the surface-distance between the line wire and the bolt, and secondly, the edges of the serrations readily evaporate any moisture which may gather upon them, thereby presenting a corresponding number of lines of comparatively absolute insulation, quite independent of the moisture which may still cling to the surface of the ware.

4461. "Dynamo-electric and magneto-electric machines." J. W. SWAN. Dated September 19. 2d. Consists of an improved arrangement of the copper conductor forming the armature or current-delivering portion of a dynamo-electric or magneto-electric machine whereby increased facility is obtained in its construction. The improved armature consists essentially of a flat spiral ring of copper whose diameter greatly exceeds its thickness, and in which are cut radial slots extending alternately from the exterior and interior of the ring partway across its width. The internal and external diameters of the ring are varied to suit with the number and size of the magnets between which it is intended to operate, so also is the number of slots and their distance apart. (*Provisional only*).

4484. "Resistance coils for electrical purposes." J. H. JOHNSON. (A communication from abroad by P. Uzel, of Paris.) Dated September 20. 2d. Relates to the adjustment of resistance coils. (*Provisional only.*)

4490. "Secondary or accumulator voltaic batteries." A. KHOTINSKY. Dated September 20. 4d. Relates to the construction and arrangement of secondary or accumulator voltaic batteries in such a manner as to obtain a large storage of electrical energy with comparatively small weight and bulk of battery. The battery consists of alternate plates or layers of two materials, the one material being either of a carbonaceous character or perforated sheet lead or network of lead, and the other material being spongy lead or in cases where great energy is required in small compass, spongy platinum or palladium. The inventor prepares the carbonaceous layer, when such is employed, by pressing together several thicknesses of canvas or other vegetable fabric and carbonising them by exposure to a red heat in a close vessel. He prepares the spongy lead in the following manner. He covers one side of a plate of zinc with an insulating coating which may be a mixture of wax and resin with a little lamp black, and immerses this plate at an angle of about 30° with its insulated side downwards in a pure solution of acetate of lead. In a short time, spongy lead is deposited on the plate, and this forms a cake which can be removed. He now places a number of the layers of either the carbon or of the perforated or network lead alternating with cakes of the spongy lead and subjects the whole to pressure so as to form a solid body which he surrounds with two or more bands of lead to which he connects the conducting wire. When spongy platinum or palladium is required it may be deposited from a solution, and employed in the same way as the spongy lead.

CITY NOTES, REPORTS, MEETINGS, &c.

The West India and Panama Telegraph Company (Limited.)

In their report for the half year ending the 31st December last, which will be submitted at the ordinary general meeting to be held on Wednesday, the directors state that the amount to credit of revenue is £40,273 5s. 2d., and the expenses have been £26,693 6s. 6d., leaving a balance of £13,579 18s. 8d., which, with the balance of £7,621 5s. 11d. brought from last account, makes a total of £21,201 4s. 7d. Having in view the small amount of the reserve fund, and the extent of the company's cables, many of which have been submerged for 12 years, the directors cannot recommend any payment on account of dividend. They have placed £15,000 to reserve, bringing up that account to £61,843 13s. 7d., and recommend that the balance, £6,201 4s. 7d., be carried forward to the next half-year's account. The directors fully recognise the extreme hardship to the proprietors of the continued non-receipt of any return upon their capital. That capital was invested in supplying a valuable service to an important region of Her Majesty's Colonial Empire, on the faith of estimates of traffic, based upon colonial statistics, and endorsed by gentlemen prominently connected with the colonies. The actual traffic has never reached the half of that calculated upon in those estimates A modification of the contracts entered into in such circumstances would appear to be an act of justice as well as of expediency, but hitherto the directors have been unable to obtain any adequate concessions from the colonies, and the company is practically existing merely to form reserve funds for the security of communications from which the British and West Indian Governments, every merchant and every enterprise connected with the West Indies, except the Telegraph Company, derive a material benefit. The traffic receipts show no substantial difference in amount from those of the corresponding period of the previous year. The subsidies received are a little in excess of the sum paid under that head in the last six months of 1881, owing to the settlement of certain arrears. The total receipts are also exceptionally increased by the s.s. *Duchess of Marlborough* having been chartered to the International Ocean Telegraph Company for the repair of one of their cables forming a link between the West Indies and the United States. Several interruptions of the company's cables have occurred during the half-year and the repairing ships have been constantly employed. At present every station is in telegraphic communication. In the last report the shareholders were informed that, acting upon a resolution of the telegraph conference held at Barbadoes in May last, Mr. Kingsford, the company's representative at that conference, was visiting the several colonies. He was so far successful in his negotiations that all the British colonies of the Antilles, with one exception, agreed to increase their subsidies. Notwithstanding the resolution referred to, which left each colony to make its own arrangements with the company for the maintenance of telegraphic communication until a satisfactory scheme were established, these increases were made subject to all the colonies joining in them. One colony refused to do so, and the good dispositions of the majority were thus rendered inoperative. Affairs having arrived at a dead lock Mr. Kingsford returned to England. Subsequently, by the courtesy of the Secretary of State for the colonies, the board was informed of the decision of Her Majesty's Government upon the proposal of the Barbadoes conference that the colonies, in conjunction with the Home Government, should establish and work lines of cables from Demerara to Halifax (Nova Scotia), and an intercolonial system to compete with the company. The Home Government declined to take part in the proposal of the conference, and in a despatch from the Secretary of State to the colonial governors, announcing this decision, and forwarding the reports of the Postmaster-General to the Treasury on the West Indian telegraph question, it was intimated that each colony would be at liberty to make arrangements with the company for the continuance of the existing service. The directors being thus relieved of an impending competition at the public expense, which would have ruined the company, laid before the Earl of Derby a proposal for strengthening the telegraphic connections of the West Indies. His lordship also received a deputation from the board at which the situation was fully discussed. Should the proposal of the directors be accepted, the subject will be submitted to the shareholders for approval. The colony of British Guiana has, by a resolution of the court of policy, increased its subsidy by £1,500 per annum for three years; and the directors are glad to recognize in this small addition to their revenue an indication of a better feeling towards the company than has hitherto been observable in that colony.

The Devon and Cornwall Electric Light and Power Company (Limited).—An official liquidator was appointed yesterday for this company.

The Submarine Cables Trust (Limited).—The report of the trustees for the financial year, which ended on the 15th of April, states that the revenue, including the balance brought from last year's accounts—viz., £1,837 10s. 7d., amounted to £23,901 3s. 2d. The dividend and bonus on the Eastern Extension Company's shares (£2,987 11s.), and the dividend on the Eastern Company's shares (£1,350 12s. 6d.) in respect of profits to 31st of December last, although not paid until after April 15th, were declared prior to that date, and are consequently included in the revenue for the past financial year. The expenses of the trust amounted to £1,333 3s. 10d. The payments of two half-yearly coupons at the usual rate of 6 per cent. per annum has absorbed £20,382, and the balance of £2,185 19s. 4d. is carried forward.

The Oriental Telephone Company (Limited).—Subject to final audit, the directors of this company will, at the annual general meeting to be held on the 30th inst., after carrying £7,000 to reserve fund, and replacing to capital the outlay on exchanges sold, recommend a final dividend of 2½ per cent., making, with the interim dividend already paid, a total distribution of 5 per cent. for the year ending December 31, 1882. The sum of £709 4s. 8d. is carried forward. The report and accounts will be posted to shareholders on Monday.

The Great Western Electric Light and Power Company (Limited).—A petition has been presented and is now pending for confirming a resolution reducing the capital from £250,000 to £195,000. The list of creditors is to be made out as for the 15th June, 1883.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations. May 16.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	7	2⅞- 3⅛	3 1/16.2⅞ 3⅛
		Do. Do.	10	5⅛- 6⅛	5⅛
30,000	5	Australasian Electric Light, Power & Storage Co.	3	⅛- ¼	
24,900	10	British Insulite Co., Limited, "A" Shares	5	1⅝- 2⅛	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	⅛- ¼	
25,000	5	Great Western Electric Light & Power Co.	2½	2⅝- 3	2⅝ x d.
24,980	5	Hammond Electric Light & Power Supply Co.	5	2⅝- 3	2⅝ x d.
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	⅛- ¼	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	⅛- ¼	
..	..	Metropolitan Brush Electric Light & Power Co.	3	..	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	⅛- ¼	
..	..	South African Brush Electric Light & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Limited	2½	1⅛- 2	1⅛
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	50½- 51½	50½
2,441,800*l.*	Stk.	Do. Preferred (Def'd. receiving no div. until	100	82½ 83½	83½ ½
2,441,800*l.*	Stk.	Do. Deferred 6 p. c. has been paid to Pref.)	100	20½- 21½	20½ ½
130,000	10	Brazilian Submarine, Limited	10	12⅜- 12½	
16,000	10	Cuba, Limited	10	10 - 10½	
6,000	10	Do. 10 per cent. Preference	10	17 - 18	
13,000	10	Direct Spanish, Limited	9	5⅜- 6½	
6,000	10	Do. 10 per cent. Preference	10	16½- 16⅝	
65,000	20	Direct United States Cable, Limited, 1877	20	12⅜- 12⅝	12½.½ d.
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	99 -102	
380,000	10	Eastern, Limited	10	10½-11	10⅝.11
70,000	10	Do. 6 per cent. Preference	10	13½- 13⅝	
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	99 -102	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	104 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	12 - 12½	12⅛.12 ¼.⅜
50,250		Do. New Shares. 1883	8	8⅝- 9	
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	103	107 -110	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	104 -107	
140,000	100	Do. do. registered, repayable 1900	100	104 -107	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	101 -104	
254,300*l.*	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan 1900	100	104 -107	
345,700*l.*	100	Do. do. do. To Bearer	100	104 -107	
22,050	10	German Union Telegraph and Trust Limited	10	10 - 10½	
163,390	10	Globe Telegraph and Trust, Limited	10	7 - 7¼	7 1/16
163,209	10	Do. 6 per cent. Preference	10	12⅝- 13	12⅝
125,000	10	Great Northern	10	12⅝- 13	
100,000*l.*	100	Do. 5 per cent. Debentures	100	101 -104	
300,000	100	Do. 5 per cent. Debentures	100	101 -104	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	28½- 29½	
100,000	100	Do. 6 per cent Debentures, 1886	100	103 -106	
17,000	25	Indo-European, Limited	25	31½- 32½	31¾ x d.
38,148	10	London Platino-Brazilian, Limited	10	4 - 4⅜	4⅛
12,060	10	Mediterranean Extension, Limited	10	1¾- 2	
8,200	10	Do. 8 per cent. Preference	10	6 - 7	
9,000	8	Reuter's, Limited	8	9½- 10	
280,000	Stk.	Submarine	100	247 -252	249½
58,225	1	Do. Scrip	1	2 - 2½	
4,200	Cert.	Submarine Cables Trust	100	108 -112	
37,350	12	Telegraph Construction and Maintenance	12	35 - 36	
150,000	100	Do. 6 per cent. Bonds, 1884	100	101 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1⅜- 1⅝	
30,000	10	West Coast of America, Limited	10	4⅜- 5	
150,000	100	Do. 8 per cent. Debentures	100	107 -109	
69,910	20	Western and Brazilian, Limited	15	6⅞- 7⅛	7
200,000*l.*	100	Do. 6 per cent. Debentures "A." 1910	100	108 -110	109
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80. red. Feb., 1910	100	100 -103	
1,500	$1,000	Western Union of U. S. 7 p.c.1 Mort.(Building)Bds.	$1,000	122 -124	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	103 -106	
88,321	10	West India and Panama, Limited	10	1⅛- 1⅜	1⅛
34,563	10	Do. 6 per cent. 1st Preference	10	7 - 7⅛	7
4,069	10	Do. 6 do. 2nd do.	10	5 - 5½	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	⅛- ¼	
200,000	1	Oriental Telephone Co., Nos. 80,001 to 300,000	½	⅛- ¼	¼
100,000	5	United Telephone Co.	5	9 - 9½	9.9½

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended April 20th amounted to £3,243, for the week ended the 27th £2,990, and for the week ended 11th inst., £2,987.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of April was 4,411, estimated to produce £3,900, against 3,937 messages, producing £3,921, in the corresponding month of last year. The January receipts, estimated at £2,800, realised £2,829.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of April, were £1,766, against £1,824 in the corresponding period of last year.

The Great Northern Telegraph Company. The receipts for April amounted to £20,400. The aggregate from January 1st to April 30th amounted to £76,920, compared with £72,350 in 1882, and £71,156 in 1881.

The Eastern Extension (Australasia, &c.) Telegraph Company (Limited). The receipts for the month of April amounted to £32,005, and £29,269 in the corresponding period of 1882.

The Eastern Telegraph Company, Limited. The receipts for the month of April, were £45,148, and £42,667 in the corresponding period of last year.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half month ended April 30th, were £3,416, as compared with £3,235 in the corresponding period of 1882.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ended April 20th, were £2,149, and for the week ended April 27th, £1,966, and for the week ended May 4th, £2,012, and for the week ended May 11th, £1,937, each after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Co., Limited.